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ABSTRACTS BOOK

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Hybrid inorganic-organic materials can be broadly defined as synthetic materials with organic and inorganic components which are intimately mixed. They can be either homogeneous systems derived from monomers and miscible organic and inorganic components, or heterogeneous and phase-separated systems where at least one of the components’ domains has a dimension ranging from a few Å to several nanometers. Hybrid phases can also be used to nanostructure or texture new inorganic nanomaterials (porous or non porous). The versatile synthetic conditions provided by bottom up strategies such as reactive molecular precursors or clusters, tunable processing temperatures and solvents and the adjustable rheology of the colloidal state allow for the mixing of the organic and inorganic components at the nanometer scale in virtually any ratio. These features, and the advancement of organometallic chemistry and polymer and sol-gel processing, make possible a high degree of control over both composition and structure (including nanostructure) of these materials, which present tunable structure-property relationships. This, in turn, makes it possible to tailor and fine-tune properties (mechanical, optical, electronic, thermal, chemical…) in very broad ranges, and to design specific systems for applications. Hybrid materials can be processed as gels, monoliths, thin films, fibers, particles or powders or can be intermediates to design materials having complex shapes or hierarchical structures. The seemingly unlimited variety, unique structure-property control, and the compositional and shaping flexibility give these materials a high potential in catalysis, biocatalysis, photocatalysis, etc.…. This lecture will describe some recent advances on integrative materials chemistry that allows via a chemistry-process coupling to tailor made nanostructured and hierarchically structured functional inorganic and hybrid materials. Some of their properties will be discussed. For more information see few recent reviews:

2. "Chimie douce": A land of opportunities for the designed construction of functional inorganic and hybrid organic-inorganic nanomaterials
4. Hybrid materials science: a promised land for the integrative design of multifunctional materials
5. Lionel Nicole Christel Laberty-Robert, Laurence Rozesa and Clément Sanchez, , Nanoscale , 2014,6, 6267-6292
7. Molecular Engineering of Functional Inorganic and Hybrid Materials
9. Nanoscaled Metal Borides and Phosphides: Recent Developments and Perspectives, Sophie Carenco, David Portehault, Cédric Boissière, Nicolas Mézailles, and Clément Sanchez. Chemical Reviews 2013 113 (10), 7981-8065
10. Aerosol Route to Functional Nanostructured Inorganic and Hybrid Porous Materials, Boissiere, Cedric; Grosso, David; Chaumonnot, Alexandra; C. Sanchez. Advanced Materials, Volume: 23 Issue: 5 Pages: 599-623, 2011
11. Applications of advanced hybrid organic-inorganic nanomaterials: from laboratory to market Sanchez, Clement; Belleville, Philippe; Popall, Michael; et al. Chemical society Reviews Volume: 40 Issue: 2 Pages: 696-753, 2011
12. Molecular and supramolecular dynamics of hybrid organic-inorganic interfaces for the rational construction of advanced hybrid nanomaterials, Grosso, David; Ribot, Francois; Boissiere, Cedric; et al. Chemical society Reviews Volume: 40 Issue: 2 Pages: 829-848, 2011
14. Titanium oxo-clusters: precursors for a Lego-like construction of nanostructured hybrid materials, Rozes, Laurence; Sanchez, Clement
15. Chemical society Reviews Volume: 40 Issue: 2 Pages: 1006-1030, 2011
17. Design, synthesis, and properties of inorganic and hybrid thin films having periodically organized nanoporosity, Sanchez, Clement; Boissiere, Cedric; Grosso, David; et al. Chemistry of Materials, Volume: 20 Issue: 3 Pages: 682-737, 2008
18. Inorganic and hybrid nanofibrous materials templated with organogelators, Llusar, Mario; Sanchez, Clement Chemistry of Materials Volume: 20 Issue: 3 Pages: 782-820, 2008

INV-36

Role of Localized Surface Plasmon Resonance (LSPR) in achieving full solar spectrum of water splitting devices

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The energy solutions for the future recommend the development of eco-friendly and economic energy sources. In this regard, natural sources such as solar energy, wind energy and biofuels have been employed to reduce the
carbon emission. Particularly, Solar energy assisted water splitting (WS) and hydrogen production has shown a promising potential.

Developing hybrid devices consisting of semiconductor materials loaded with noble metals is a milestone to achieve efficient WS process. Indeed, adding localized surface plasmon resonance (LSPR) nanoparticles (NPs) such as Au to a suitable oxide material, the optical activity of the composite metallic dielectric photonic crystal (MDPhC) material can be significantly enhanced. An LSPR metallic particle absorbs the light in visible—IR ranges and subsequently provides hot electrons to the attached metal oxide layer. Hence, metal oxide catalyst could pursue its hydrogen generation process over the full solar spectrum.

Investigating the plasmonic behavior of the metallic NPs is important as it provides information about the interaction process of a composite NPs-metal oxide with light and further it provides feedbacks about designing efficient devices.

The MPhC used in this investigation, is based on TiO$_2$ acting as the WS catalyst and Au NPs as the LSPR material. In this case, the WS activity fundamentally can depend on the (i) production rate of hot electrons in the Au part through plasmon resonance, (ii) the transport of the hot electrons produced in Au to the TiO$_2$ material, and (iii) the crystallinity of the catalyst (TiO$_2$).

This talk will be tackling all these aspects and highlighting the importance of LSPR materials as well as the catalyst microstructure and their impact on water splitting activity of the WS device.

**INV-4**

**On the fabrication of nanostructures with electron and ions**

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Focused ion beam (FIB) technology came a long way from its advent in the seventies, when their utility for maskless doping of silicon was first proposed. Today it plays an important role in applications, which range from micro- and nanofabrication to sample preparation and materials characterization. This contribution concentrates on the fabrication of nan-objects with electrons and ions *in-situ* inside a dual beam scanning electron and focused ion beam microscope.

In particular we have explored a new phenomenon, i.e. ion-induced bending phenomena which may serve as a versatile tool to manufacture nanostructured devices. Bending was studied in free standing cantilevers and this phenomenon of bending of cantilevers towards the incident beam is discussed in terms of local volume change due to accumulation of radiation induced vacancies and substitutional atoms. A model is proposed to explain the observations, based on a set of rate equations for concentrations of point defects, i.e. vacancies, self-interstitials and implanted Ga atoms. The influence of preexisting defects is also discussed. In addition to ions, also electrons can used to manufacture nano-objects inside the electron microscope. Recent examples will be highlighted of nanoclusters of metallic systems we have produced and studied through focused-electron-beam induced deposition.

The work shows that an in-depth understanding of focused electron and focused ion beams can play a predictive role in a quantitative control in for the nanofabrication of small-sized nano-products.
INV-17

Nanostructured Cu species in low loading copper-based methanol synthesis catalysts

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CuO-ZnO based catalysts are of great scientific and industrial interest due to their activity for the low temperature–low pressure synthesis of methanol. Before use, these catalysts are typically activated in a H₂ diluted stream. During this treatment, copper oxide species are reduced to Cu metal. The extent of reduction and, in particular, the temperature at which this process occurs are strongly influenced by the interaction between the CuO and ZnO particles. Moreover, also the reactivity of metal copper in the reduced catalysts can be influenced by ZnO. All these effects are remarkably affected by homogeneity and interdispersion of the oxides particles. Indeed, the catalytic activity remarkably increases if a higher homogeneity and interdispersion of the oxides is achieved in the catalyst. A TPR (Temperature-Programmed Reduction) investigation revealed the nature and extent of the interaction in CuO-ZnO catalysts either in the oxidized and in the reduced state. A set of CuO-ZnO catalysts of relatively high surface area and crystallite size below 100 Å was obtained by thermal decomposition, at 623 K in air, of hydroxy carbonates precursors prepared by coprecipitation at constant pH, this method leading to well dispersed CuO-ZnO mixed oxides. The TPR study in H₂ has evidenced that there is a strong interaction of CuO with ZnO. Such an interaction remarkably increases on decreasing the copper content. Indeed in the catalyst at lower copper loading (Cu:Zn=10:90 and 5:95 as atomic ratio), a fraction of very small, and then also very likely to be nanostructured, CuO-like particles are so strongly interacting with ZnO that they are reduced at a temperature lower than 50 K with respect to the CuO species in the other catalysts. A further relevant finding is that copper metal in the reduced catalysts can be partially re-oxidized by CO₂ at 573 K for 0.33 h to form very tiny and even more nanostructured CuO-like species that are extremely reactive, much more than those of the fresh catalysts.

INV-21

Antibacterial properties of food packaging with incorporated Nano-Diamond

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The detonation-produced Nano-Diamonds (DND) have antioxidant properties. Therefore, they are suitable for use in food packaging. DND is introduced into the polymer material structure in the corona treatment process, which is sometimes referred to as air plasma [1]. The packaging material used for this purpose is a multi-layer foil laminate containing PET, PP and PE. Recent studies have shown that foods containing fatty acids are characterized with a lower degree of rancidity if are stored in a DND incorporated packaging foil [2]. In this work, antibacterial properties were verified using foodborne bacterial and fungi pathogens like E. Coli, St. Aureus, St. Epidermidis and C. Albicans. The proliferation and population growth of these pathogens on the
foil surface were studied. The outstanding results may indicate the possible use of this technology in packaging industry in the future.


**INV-27**

**Studies of chalcogenide nanocrystallites operated by coherent laser induced beams**

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Complex studies of novel chalcogenide nanocrystals (NC) of the kesterite type Cu₂ZnSnS₄ (CZTS) and its derivatives were studied using an external laser light. Single phase metastable wurtzite-like CZTS were synthesized by one-pot method. The NC sizes were varied within 10 nm...60 nm. After these NC were embedded into the different polymer matrices with concentration varying from 20 % up to 40 %. Among the materials we explore pure CZTS NC and partially doped by Se (up to 13 %). For operation by the NC optoelectronic parameters like transparency, refractive indices, birefringence, reflection etc. we have applied laser optical treatment at different wavelengths and power densities. It was established that the optimal sizes of the NC for the efficient operation were existed at 30...40 nm. Outside this region the photoinduced optical constants were significantly less. The CSTZ NC were embedded in the different polymer matrices: PMMA, PVC, PVA, olygoether acrlyate photopolymer etc. The maximal shift of the transparency and of the fundamental absorption edge were achieved for the PVA matrices. The photoinduced processes performed by the single laser beams disappeared after several minutes of treatment. At the same time the use of the bicolor and three-color coherent treatment allowed to obtain the changes of the values for the operated optical parameters up to 20...30 %. And the relaxation times were enhanced up to several hours. The photoinduced results also were very sensitive to the laser shape and the optimal changes were achieved for the Gaussian-like laser profiles. The effects of changes after laser irradiation were explored. Following the performed calculations a principal role of the near the surface NC states was explored. The observed effects are a consequence of coexistence of local laser heating, and formation of the photoinduced gratings with the laser formed local dc-electric field. The studied may be used for creation of the nanocomposites operated by external laser beams.
Operation by optoelectronic features of photopolymer embedded nanocrystallites

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Cadmium sulfide nanoparticles were fabricated by electrolysis of aqueous sodium chloride (20 g/l or 0.856 mol/l) and thiourea (10 g/l or 0.133 mol/l) with a soluble cadmium anode and Polvynil alcohol (PVA) by 373 K with current density (0.1 or 0.2 A/cm2). PVA with viscosity molecular weight is 15,000 g/mol was used as a possible regulator of particles size. It was shown a possibility to change the effective nonlinear optical constants using external laser beams. The operation have lead to effective changes of the NP sizes, their aggregations etc. The principal role is played by the laser excitation of the nanosheets. So the effect is very sensitive to the sizes. It is shown that the efficiency of operation is very sensitive to the nanocrystallite sizes. The possible aggregations may be additionally varied due to laser treatment. The effect shows a drastic dependence on the temperature within the 77 K…300 K. The more efficient was appeared to be Er. glass nanosecond lasers with power densities varied up to 150 MW/cm2. The complex studies of the structure morphology and the output nonlinear optical susceptibilities were performed at different laser illumination power densities. The possible applications of the studied nanocrystallites is shown for the laser light modulations, defectors, and optical memory devices. The further optimization of the nanocrystallites is discussed.

From tungsten minerals to sintered cemented tungsten carbides: the carbothermic reaction shortcut.

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Cemented tungsten carbides (WC-Co) have outstanding properties owing to the combination of high hardness and strength of tungsten carbide (WC) with the toughness and plasticity of the metallic binder. The application of cemented carbides has become universal in the manufacturing sector due to their high hardness, toughness, and elevated temperature strength properties to resist plastic deformation at high temperatures. Processes which allow synthesizing WC powders by reducing significantly the use of chemicals and the amount of industrial
waste, as well as by decreasing the number of high-temperature processing steps and their temperatures as well, are particularly appealing from an environmental and sustainability point of view. For these reasons, there is a renewed interest in the carbothermic reduction of tungstates and, in particular, of scheelite (CaWO₄). For the first time we will give figures about energy savings and reduced waste production in the carbothermic reduction of enriched scheelite minerals, and will show that tungsten carbide (WC) powders synthesized from said minerals can be employed industrially for the liquid-phase sintering of cemented carbides (WC-Co) with the expected properties. The carbothermic reduction of scheelite does represent a viable process for eco-friendly, energy efficient and lower cost synthesis of cemented tungsten carbides.

INV-31

2D hexagonal boron nitride synthesized by a polymer route

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With the continuous development of the electronic devices field, research on 2D materials has remarkably developed in the past few years. Especially, widespread interest in graphene has been driven by its excellent capacity for charge transport within the atomic plane [1]. However, since graphene’s properties are strongly linked to the substrate on which it is deposited, the promising future of practical devices will necessarily go through the development of insulating substrates on which graphene can be deposited without changing its intrinsic properties. One of the most suitable substrates appears to be hexagonal boron nitride (h-BN), which is isostructural and isoelectronic of graphene. As a consequence, the development of a novel source for highly crystallized h-BN crystals, suitable for a further exfoliation, is of prime scientific issue. This presentation proposes a promising approach to synthesize pure and well-crystallized h-BN flakes, which can be easily exfoliated into Boron Nitride NanoSheets (BNNSs) [2]. This new accessible production process represents a relevant alternative source of supply in response to the increasing need of high quality BNNSs. The synthesis strategy based on a unique combination of the Polymer Derived Ceramics (PDCs) route with the Spark Plasma Sintering (SPS) process [3] shows large, defect-free and well-crystallized h-BN flakes, which are key-characteristics for a subsequent exfoliation into relevant BNNSs.

Structure and adsorption properties of graphene oxide decorated with iron oxides

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Graphene oxide was prepared by the modified Hummers method and was decorated by a hydrothermal route with Fe oxides from a 2:1 Fe³⁺/Fe²⁺ precursor solution, varying the total Fe contents and performing a final reduction treatment with N₂H₂ in some samples to compare with others without N₂H₂ reduction treatment. The materials were characterized by Transmission/Scanning Electron Microscopy, Fourier Transform Infrared Spectroscopy, Raman Spectroscopy, Energy Dispersive X-ray Spectroscopy, X-ray Diffraction and X-ray Absorption Near Edge Spectroscopy. The water dispersibility and kinetic adsorption power of each material were assessed in front of a 5 ppm methylene blue solution. In the most diluted (respect to total Fe), unreduced sample, well defined, quasi-spherical, crystalline nanoparticles <10 nm evenly distributed onto the graphene sheet were observed. Nanotube formation is evident upon reduction with hydrazine, correspondingly oxygen contents dropped from 60 % at to 45% at. There is evidence of iron oxide nucleation on the carboxy moieties, while bands attributed to Fe-OH and Fe-O vibrations were observed. Raman spectra suggest the presence of magnetite, hematite, maghemite and goethite phases. Further confirmation of these phases, as well as its quantitative distribution was obtained from Rietveld refinement of the XRD pattern and Fe K-edge XANES spectra. The more diluted and non-reduced sample, displayed the higher capacity of MB adsorption of 30 mg/g in a 0.5 mg/mL decorated graphene oxide dispersion. The material offers great potential for reusable adsorbents for wastewater treatment.

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HFCVD Diamond Film on Vanadium Carbide Interlayer Applied by Laser Cladding

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A suitable intermediate layer development for synthetic diamonds deposition on steels has been the current challenge in high performance cutting tools development. The main difficulties for CVD diamond deposition relates to film adhesion. Film delamination may occur in cooling down after growth because of the difference between coefficient of thermal expansion (CTE). Low adhesion also develops because of graphite formation in the interlayer, which occurs by the presence of transition metals at the surface of the material were the diamond deposition reaction happens. Vanadium carbide (VC) has attractive characteristics, such as high adherence to the carbon steel substrate, hardness of 3200-3800 HV, forms a low-porous film and has intermediate CTE (6.06x10⁻⁶K⁻¹) between steel (11.6x10⁻⁶K⁻¹) and diamond (0.8x10⁻⁶K⁻¹) [1]. The VC appears as a promising material to attenuate the residual thermal stresses and to form an efficient diffusional barrier. The VC powder was processed by laser cladding. The laser cladding followed two stages: powder dispersion on the material surface by a spray gun and, the laser beam focusing on the VC powder. A weld puddle forms on substrate surface and the substrate acts as an efficient heat spreader causing rapid coating solidification [2]. The laser parameters such as resolution (DPI), scanning speed (mm/s) and number of heating cycles (NHC) were varied to build a multilayer coating. The diamond films deposition occurred in a HFCVD reactor for a 3h period. The results were obtained by X-ray diffraction, scanning electron microscope, Rockwell C test and Raman spectroscopy.


The Effect of Concentration and pH of PBS to the Electro catalytic Performance of Enzymatic Glucose Biosensor

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In this study, the enzymatic glucose biosensor was developed by modifying indium tin oxide (ITO) glass electrode with iron oxide nanoparticles (IONPs), glucose oxidase (GOx) enzyme and nafion (Nafion/Gox/CA-IONPs/ITO). IONPs were synthesized using precipitation technique and surface functionalized using citric acid (CA). The effect of concentration and pH of phosphate buffer saline (PBS) to the electrochemical performance of the modified electrode for glucose biosensor detection were studied. Increasing the PBS concentration increased the electrochemical performance of the bioelectrode whereas pH of PBS buffer solution affected the
GOx activity. From the transmission electron microscopy (TEM) images, the size of IONPs obtained was ~19 nm and the X-ray diffraction (XRD) spectra showed the presence of spinel cubic lattice of maghemite ($\gamma$-Fe$_2$O$_3$). The Nafion/GOx/CA-IONPs/ITO bioelectrode showed good electrochemical performance to glucose detection. The functionalized CA-IONPs acted as the catalyst and help to improve the electron transfer rate between GOx and ITO electrode. In addition, thin nafion film coated on the electrode prevented interference and improve chemical stability.

**NANO-9**

**Proliferation on bio-sensing application by chemical approach method: In vitro cytotoxicity effect and antibacterial performance of microvascular endothelial cell A549 activity on Zinc oxide doped SWCNT nanocrystals**

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Zinc oxide (ZnO) and single-wall carbon nanotube (SWCNT) are important materials in the ongoing efforts to introduce new nanotechnology devices. These materials are commonly used in building devices, such as sensors and solar cells; the step is important for developing optoelectronic and medical healthcare devices. Mediators are used and sought to modify the bioelectronics properties of the abovementioned materials. In addition, various aspects related to the applications of biologically modified SWCNTs and ZnO in sensors and cytotoxicity of ZnO:SWCNTs at 300 °C were discussed. Copper plate contributes to the catalytic systems, which in turn enhance the analytical performance of the gas sensing devices and cytotoxicity results. This study aimed to reduce the cytotoxicity effect of ZnO:SWCNTs on cell function, as such effect can cause serious oxidative stress and DNA damage to human lung epithelial A549 cell lines. SWCNTs can easily entangle and agglomerate because of their long length and low diffusive mobility in the base fluids. The effects of nanoparticle (NP) against exposure on the cell membrane have been duly addressed to date. However, this interaction may alter cell metabolism and cell integrity and is important in understanding the modifications of the cell membrane. The uptake mechanism of pulmonary A549 cell line by NPs and the molecular pathway during the initial cell responses are still unclear. Thus, additional research efforts must be made to properly characterize ZnO:SWCNTs and thus effectively improve the growth mechanism.

NANO-10

Synthesis and characterization studies of Ceria doped CuO nanocrystals by hydrothermal method

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Cerium oxide (CeO\textsubscript{2}) is a well-known semiconductor for its wide band gap (3.37 eV) and high excitation binding energy of 60 meV at room temperature. This report is an account of studies that were carried out on the synthesis and catalytic properties of pure cerium oxide based nanocomposites. In this study, CeO\textsubscript{2}-CuO nanocomposites has been prepared from Cerium Nitrate [Ce(NO\textsubscript{3})\textsubscript{3}.6H\textsubscript{2}O], Copper (I) nitrate [Cu(NO\textsubscript{3})\textsubscript{2}] and Polyethylene Glycol (PEG) as a precursor via hydrothermal method characterization of nanocomposites was carried out using X-ray powder Diffraction (XRD), Ultraviolet-Visible-Near Infrared (UV-vis-NIR), High resolution Transmission Electron Microscopy (HRTEM) and micro-Raman images indicated that the chemical molecular vibrational band structure and morphology of the product which is spherical shaped nanoparticles with an average particle size of 10 nm with standard deviation. Therefore, there is considerable interest for studying such materials not only for future applications but also from a fundamental point of view.


NANO-11

Polypyrrole-AgNPs-Graphene Nanocomposite Deposited on Carbon Fibre Paper for High Performance Supercapacitor

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In this current study, a nanocomposite of electrochemical double layer capacitive graphene, pseudocapacitive polypyrrole (PPY) and highly conductive silver nanoparticles (AgNPs) was presented. Firstly, silver nanoparticles-graphene nanosheets (AgNPs-GNs) nanocomposite have been synthesised by a one-pot microwave-assisted reduction technique, followed by an interfacial/in situ oxidative polymerization of polypyrrole in the presence of AgNPs/GNs to produce high-quality nanocomposites for supercapacitor application. The synthesised PPY-AgNPs-GNs was coated on a two-dimensional textured carbon fibre paper (CFP) due to its large surface area, high porosity, ultra-lightness, good electric conductivity, and excellent chemical stability in various liquid electrolytes [1]. Electrochemical measurements showed high capacitance and excellent rate capability for the fabricated PPY-AgNPs-GNs/CFP nanocomposite electrode. Additionally, the electrode developed in this work possesses very high areal capacitance of 5.9 F cm\(^{-2}\) at the current density of 5 mA cm\(^{-2}\). As for the cycling stability, the initial specific capacitance decreases only from 4.56 F cm\(^{-2}\) to 3.35 F cm\(^{-2}\) after 5000 cycles under a current density of 30 mA cm\(^{-2}\).


NANO-12

A novel zinc zirconate (ZnZrO\(_3\)) nanocomposites bimetallic designed by Green synthesis via Moringa Oleifera extract for high electrochemical supercapacitors

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We present, for the first time, a novel zinc zirconate (ZnZrO\(_3\)) nanocomposites bimetallic prepared by Green synthesis via Moringa Oleifera extract for electrochemical performance. To the best of our knowledge, a green chemistry route to synthesize an asymmetric supercapacitor device using ZnZrO\(_3\) nanocomposites has not been published before. Green chemistry routes are on the rise due to their various advantages including cost effectiveness, no requirement of additional chemicals, reliability and the fact that is a very easy, environmental friendly method with a minimum of waste generation. Moringa oleifera plant is reported as sources of bioactive compounds including antibacterial, antifungal activity, antitumor, antiepileptic, anti-inflammatory, antidiabetic, antiulcer, antioxidant and cholesterol lowering. Every part of the plant contains minerals, source of protein, amino acids and vitamins. These bioactive compounds have been shown to serve as both reducing and stabilizing agents for the fabrication of metal/bimetallic oxides nanocomposites. Their electrochemical activity, crystalline structure, morphology, isothermal behavior and optical properties will be studied using various characterization techniques such as X-ray diffraction (XRD) and Energy Dispersive X-ray Spectroscopy (EDS) cyclic voltammetry (CV), galvanostatic charge–discharge (GCD) and electrochemical impedance spectroscopy (EIS) Fourier transform-infrared (FTIR), High Resolution Transmission Electron Microscopy (HRTEM), Differential scanning calorimetry/thermogravimetric analysis (DSC/TGA), Ultra-violet visible (UV-vis) and Photoluminescence (PL). The mechanism of ZnZrO\(_3\) nanocomposites formation via the reaction of the precursors and photochemical bioactive compounds will be presented.
NANO-13

Green synthesis of novel Zinc cadmium oxide (ZnCdO) nanocomposite via Moringa Oleifera natural extract for applications in Energy Storage, Catalysis, and as Conductive Materials

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The main motivation of the research study involves development of reliable, accurate, inexpensive and environmental friendly method for the synthesis of novel bimetallic oxide (ZnCdO) nanocomposites through green synthetic method using Moringa Oleifera extract for the application in energy storage, catalysis and as conductive materials. For the first time, we used green synthetic route via Moringa Oleifera extract as a chelating and reducing agents for the synthesis of ZnCdO bimetallic nanocomposites. These nanocomposite materials will be characterized using different techniques, such as Cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) for electrochemical activities, High Resolve Transmission Electron Microscope (HRTEM) for the physical property such as particle size and distribution, morphology, structure, UltraViolet -vis spectroscopy (UV/Vis spectra) and Photoluminescence (PL) analysis for optical studies, X-ray diffraction (XRD) for purity and crystalline structure and DSC/TGA for thermal studies. Their potential as an electrochemical catalyst and energy storage will be studied and modelling using electrochemical Impedance Spectroscopy (EIS), galvanostatic charge–discharge (GCD) and cyclic voltammetry (CV).

NANO-14

Nd and Gd Co-doped Ceria-based Nano Composite Electrolyte for IT-SOFCs Prepared by Sol-Gel Method

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Neodymium and Gadolinium co-doped ceria (GDC-Nd) is a promising alternative as a solid electrolyte for intermediate temperature solid oxide fuel cell (IT-SOFC) due to its low operating temperature and its high electrical conductivity. Ce₀.₉Gd₁₋ₓNdₓO₂₋₂ powders, with 10 mol% of gadolinium were successfully synthesized with a sol-gel method and citric acid as an organic precursor. The samples were calcined at temperature of 1050°C and 1150°C. The powders properties were then characterized by X-ray diffraction, transmission electron microscopy, scanning electron microscopy, thermal gravimetry analysis, and the sintered pellets were evaluated by electrochemical impedance spectroscopy. The TEM analysis showed that the particles size were approximately smaller than 50nm. Sintered GDC-Nd samples exhibited the maximum theoretical density of 96%. The electrical conductivity vs temperature showed
values ranging from $1.5 \times 10^{-2}$ to $3.9 \times 10^{-2}$ Scm$^{-1}$ at 600°C and 800°C for GDC-Nd with 10% mole of gadolinium and calcined temperature 1150°C. The methodology investigated showed a better control of stoichiometry, impurities, and low cost. Characterization results demonstrated that these materials can be applied in IT-SOFCs due to high ionic conductivity at the range of intermediate temperature (600-800°C). The high ionic conductivity is related to the improve mobility of gadolinium ions in a high-density structure.


NANO-15(2)

Enhanced photocatalytic activity of MoS$_2$/Si-doped TiO$_2$ nanotube hybrids with highly efficient interface effect

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Interface-induced effect and large specific surface area of heteronano-structures are attracting much attentions due to applications in photocatalysis. In this work, TiO$_2$ and Si-doped TiO$_2$ nanotubes were prepared solvothermal method followed by treatment in NaOH aqueous solution used to construct hybrids with MoS$_2$ nanocrystallines by a modified chemical method. The effects of the Si doping and MoS$_2$ decoration on the microstructural, optical and photocatalytic properties of the nanotubes and hybrids in the degradation of dye malachite green and naphthol green B were studied. The hybrids showed larger specific surface area than the NTs because of well controlled formation process of MoS$_2$ nanoparticles. The Si-doping reduced light absorption, but increased the specific surface area, hydrophilicity and photo-induced ultrahydrophilicity. MoS$_2$ decoration enhanced the light absorption and further increased the the specific surface area, hydrophilicity and photo-induced ultrahydrophilicity of the nanotubes. Moreover, MoS$_2$ decoration also proved highly efficient interface-induced effect between the NTs and MoS$_2$. Thus, Si-doping and MoS$_2$ decoration remarkably enhanced the photo-catalytic activities of the TiO$_2$ NTs in the dye degradation.

NANO-15

Self-cleaning properties of reduced graphene oxide/TiO$_2$: Mo hybrid thin films with efficient synergistic enhancement effect

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Self-cleaning is an important technique in environmental purification. This work focus on enhancing self-cleaning properties of TiO$_2$ film utilizing synergistic effect of reduced graphene oxide (rGO) and Mo cation. A series of rGO-TiO$_2$:Mo nanohybrid films were deposited and characterized by various analysis techniques. The
self-cleaning properties including photocatalytic activity, photoinduced superhydrophilicity and conductivity remarkably enhanced with increasing contents of rGO and Mo. The synergistic effect of rGO and Mo on the self-cleaning properties was observed. The interface-induced effect was confirmed by the measurements of band energy level and photoluminescence. The films were photoacidic and varied with Mo and rGO contents.

NANO-16

Modified polyurethane nanofibers for antibacterial purification of water and air

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Nanofibers with antibacterial agents are a promising variant of the efficient filters for antimicrobial purification of water and air. In the presented research Polyurethane (PU) nanofibers were modified by microparticles (700 nm – 1 µm) and nanoparticles (≈50 nm) of copper oxide (CuO) in order to compare the influence of the dimensional characteristics of modifier on the properties of composite filters. Antimicrobial additives (used concentrations 5; 7; 9.5 and 12% wt) were introduced directly into the pre-electrospinning solutions and then were thoroughly intermingled. Two types of spinning techniques were used for the production of composite nanofibers. The spinnability of modified solutions was checked by the rod spinner. Then an industrial Nanospider technique was applied for the production of PU nanolayers. Two types of spinning electrodes (cylindrical rotary electrode with needle surface and static wire electrode) were used with the aim to select more suitable approach for the processing of modified solutions. It was found out that the cylindrical electrode with needle surface is required to prevent the precipitation and aggregation of modifiers particles and to provide production of the efficient antibacterial filters from composite solutions. The antibacterial efficiency of the nanofibrous mats with micro- and nanoparticles was studied using the model microorganisms Escherichia coli and Staphylococcus Gallinarum. The stability of particle fixation into the fiber structure was determined under the simulated conditions of water filtration. Moreover, a special device AMFIT-13 was designed and used to characterize the bacterial filtration efficiency of nanofibers for air purification. A very important conclusion of this study is a proven fact that PU nanofibers modified by microparticles of CuO are more appropriate materials for the antibacterial purification of air and water than corresponding nanofibrous layers with nanoparticles.
NANO-17

EFFECT OF PURITY CeO$_2$ ON ELECTROCHEMICAL PROPERTIES OF LaNi$_5$ – TYPE ALLOY ELECTRODES

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The addition of rare earth oxides (La, Ce, Pr, Er, Tm, Yb) on the LaNi$_5$-type alloy electrodes, have been studied and applied in rechargeable Ni-MH batteries due to improves battery performance. Two type of negative electrode (anodes) material were made from solid state mixing of 1% CeO$_2$ (Sigma Aldrich $\geq$ 99%) and 1% CeO$_2$ (Local Product, 79.44% Ce) namely LaNi$_5$Ce (A) and LaNi$_5$Ce (B), respectively, to LaNi$_5$ powders. The powder mixtures were mechanically milled at 240 rpm for 2 hours using ball mill. The powders properties were then characterized by X-ray diffraction, X-ray fluorescence, Brunauer–Emmett–Teller (BET), and the pellets were evaluated by electrochemical impedance spectroscopy. LaNi$_5$Ce (A) form a semicircle pattern greater than semicircle pattern on LaNi$_5$Ce (B). Semicircle pattern on LaNi$_5$Ce (B) is smaller than the LaNi$_5$ without addition. The methodology investigated showed a better purity will increase semicircle pattern of impedance. Furthermore, characterization results the value of ionic conductivity with the highest conductivity is 1.5332 S/cm. The high ionic conductivity is related to the mobility of hydrogen ions in anodic structure.


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Molecular Dynamics simulations of plasma sputtered ternary nanocatalyst growth

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On the one hand, Pt based ternary alloys are known to improve the activity and stability of PEMFC’s catalysts. [1-2]. On the other hand, magnetron sputtering deposition has already demonstrated its ability for the fabrication of efficient PEMFC electrodes with high Pt utilization rate [3]. In the present study, MD simulations on PtₓMᵧNₜ (M; N, being less noble or common metals) deposition and growth are carried out for studying the preferred morphology and structure (size, geometry, atomic arrangements …) of such clusters. Recently, it has been shown that MD simulations allowed confirming and predicting the morphology and structure of Pt nanocatalysts [4,5] as well as of PtₓPdyAuₜ nanomaterials [6], for which, a comparison is provided between sputtering and chemical methods. Initial conditions of MD simulations are selected for matching experimental chemical and physical synthesis methods of nanoparticles. Ternary catalyst PtₓPdyAuₜ, PtₓNiₘAuₜ, PtₓCuₘAuₜ and PtₓNiₘCuₜ supported on porous carbon mimicking gas diffusion layers are studied. Radial distribution functions and X-Ray Diffraction pattern are systematically computed for enabling direct comparison with experiments.


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Zinc Tin Oxide (ZTO) is a ternary semiconducting oxide material known for its unique structural, electronic and optical properties [1, 3]. ZTO nanomaterials were synthesized using natural extracts from Aspalathus Linearis as effective chelating agent. Green synthesis is a very effective method when compared to other methods of synthesis at low temperatures [2]. The particle size, structure and surface morphology of the obtained nanomaterials were investigated using high resolution transmission electron microscopy (HRTEM), High resolution scanning electron microscopy (HRSEM), selected area electron diffraction pattern (SEAD), energy dispersive X-rays (EDX), Raman spectroscopy, fourier transform infrared spectroscopy (FTIR) and X-ray crystallography (XRD). Thermal properties of ZTO nanomaterials were studied by using differential scanning calorimetry/ thermo gravimetric analysis (DSC/TGA). The electrochemical activities of the ZTO nanomaterials were examined by electrochemical measurements, including cyclic voltammetry (CV), square wave voltammetry (SWV) and electrochemical impedance spectroscopy (EIS).


Green Synthesis via natural extracts of Aspalathus Linearis and characterization of PtNiCu nanoparticles and their high electrocatalytic activity on methanol oxidation.

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The direct methanol fuel cell or DMFC is emerging as a promising alternative energy source for many applications [3]. The advantages of DMFC is that it offers high conversion efficiencies with low or no pollution and methanol is a liquid and can be easily stored [1, 2]. The synthesis of PtNiCu nanoclusters via natural extracts from Aspalathus Linearis acts as both capping agent and oxidising agents. Their morphology, structure and composition were investigated by high resolution transmission electron microscopy (HRTEM), selected area electron diffraction pattern (SEAD), energy dispersive X-rays (EDX), X-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS). These PtNiCu nanoclusters catalysts showed a larger surface area, a stronger CO tolerance and a higher catalytic activity towards electrochemical oxidation of methanol using cyclic
voltammetry (CV) and square wave voltammetry (SWV). Electrochemical impedance spectroscopy (EIS) investigated the catalytic activity in terms of charge transfer resistance ($R_{ct}$).


NANO-27

Molecular Simulation Study of Niosome Monolayers with and without Cholesterol Incorporation at the Water-Air Interface

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Molecular dynamics simulation technique has been employed to investigate the structural and dynamical properties of niosome monolayers with and without cholesterol incorporation at the water-air interface. The niosome monolayers obtained from the pure sorbitan monostearate (Span 60) and the mixture of Span60 and cholesterol with different compositions including 10%, 20%, 30%, 40%, 50%, 60% chol were modeled for this study. The simulations of niosome monolayers have been performed at a constant pressure of 1 bar and temperatures of 300 K, respectively by using Gromacs 5.1.2 package. The results obtained from this study provide more insight on the key mechanism and structural characteristics of niosome films such as molecular spacing, molecular packing and dynamical properties of niosome monolayers. The niosome monolayer with cholesterol inclusion show higher compressibility and mobility, leading to the phase change from the gel phase to liquid order phase. It is also found that the monolayer thickness and molecular area of the niosome with cholesterol inclusion were increased. The niosome with 50% cholesterol inclusion shows the remarkable physical properties such as the higher compressibility and molecular packing. Additional, the water contents and cholesterol molecules play important role on the film stability and phase formation which such information can be directly compare with the experimental data. Finally, it is hope at the end of the study that some information can be useful in aspect of design and development of drug delivery systems.


NANO-29

Ferromagnetic Heterojunctions VO$_2$/Co$_3$V$_2$O$_8$ Materials for Photocatalytic Degradation of Fuchsins Magenta Dye

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Dense hybrids frameworks are emergent multifunctional materials which present much promising applications such as energy harvesting and storage, biomedicine, sensing and microelectronics [1]. We report the structural and ferromagnetic properties of Co-V nanorods prepared using simple sol-gel method route. The as obtained samples were characterised with powder XRD, X-ray photoelectron spectroscopy, Scanning Electron Microscopy, Differential Scanning Calorimetry and the temperature dependence of infrared spectrum. The photocatalytic activity of the hybrids ferromagnetic nanorods based VO$_2$/Co$_3$V$_2$O$_8$ was tested using Fuchsin Magenta dye as a pollutant for an illumination time of 360 min.


NANO-30

Shape Control VO$_2$ Nanorods Prepared By Soft Chemistry

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The crystallization process plays an important role in determining the crystal structure, shape, size and size distribution of the nanomaterials [1]. It was described theoretically by the LaMer, the nucleation and growth of nanoparticles procedure following Ostwald ripening [2] to describe the change in the particles size. VO$_2$ has attracted tremendous interest over almost half a century and is a benchmark problem of solid state chemistry because of its near room temperature metal semiconductor phase transition between a monoclinic insulator and a rutile metal, at a critical temperature Tc of 340K [3-5]. Simultaneous control of the size and morphology of VO$_2$ nanoparticles was obtained via soft chemistry Ph dependance. The VO$_2$ nanorods was systematically studied by X-ray diffraction, Scanning electron microscopy, Raman Spectroscopy, Fourier Transform IR and Differential Scanning Calorimetry. It is demonstrated that the nucleation and growth of the particles have great influence on the morphology and the alignment ordering of VO$_2$ nanorod arrays. Pre-treatment of as-synthesized materials of VO$_2$ nanoparticles plays a main role in governing the material diameter and crystallinity. The temperature of nucleation and growth was shown to have great impact on the crystal size and the frequencies of vibrations within the material.

[1] www.intechopen.com


NANO-31

Structural study of femtosecond laser irradiated germanium thin films

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The resilience of germanium thin film under the irradiation of energetic photons from the femtosecond laser source is investigated in this paper. Germanium thin film was grown on a glass support using vacuum deposition technique. The coating was then irradiated with various laser fluences to study microstructural and morphological response of the film due energetic photons. A 1030 nm laser source with a 20 kHz repetition rate and pulse energy in the micro joule range was used in this study. From the X-ray diffraction patterns of the as-deposited film, microstructure of the film was found to be amorphous in nature, this phase proved to be dominant even after high laser fluence irradiation. The Raman spectroscopy however showed some evolution in the microstructure of the film as a function of laser fluence. Furthermore, high-resolution scanning electron microscope of the film revealed some microstructural damages of the film due to the laser irradiation. UV-Vis –NIR study of the film was also conducted and the optical behaviour of the film is also reported in this paper.


NANO-32

Titanium thin films after femtosecond laser heating

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Titanium is a multi-valence transition metal that is capable of forming polymorph oxides depending on the experimental conditions. These oxides of titanium can be realised either by using chemical method, physical deposition or using ultra-fast laser annealing of the titanium thin film in air to form a layer of titanium oxide onto the titanium support. In this study femtosecond laser was used to oxidize the top layer of the titanium thin film on a glass support, by exposing a titanium film to train of pulses of infra-red laser with a repetition rate of 20 kHz and pulse energy of few micro-joules while translating the film in a square pattern. The microstructure of the film was studied using X-ray diffraction machine, furthermore scanning electron microscope was used to study the morphology of the film due to laser exposure. UV-Vis-NIR revealed the optical response of the oxide
formed after laser annealing of the films, and the Raman spectroscopy showed a relationship between the laser fluence and the vibrational modes of the titanium oxide formed.


NANO-33

Synthesis, Characterization, and Thermal Conductivity Enhancement of Silver Nanowires Based Nanofluids

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Nanofluids have a potential as a new class of heat transfer fluids which could increase the efficiency of solar thermal systems. In this paper, thermal conductivity measurements were made on suspensions of silver nanowires (AgNWs) in ethylene glycol (EG) which were prepared by a simple and cost effective chemical synthesis method. AgNWs with high aspect ratio (≥200) were obtained by using EG and polyvinylpyrrolidone (PVP) as reductant and structure-directing agent, respectively. Structural and morphological characterizations revealed crystalline three-dimensional (3D) interconnected network of AgNWs suspended in EG. The thermal conductivity measurements were conducted in the temperature range 25 < T < 50oC using a guarded hot plate (GHP) method. An enhancement in the thermal conductivity of the fluid, when aged for 5hours, of up to 23% was found. To better understand the thermal conductivity enhancement of the fabricated AgNWs:EG nanofluid, the experimental results were compared with the theoretical values predicted by Nan’s model. A linear relationship between thermal conductivity and volume fraction of silver nanoparticle was found together with significant temperature dependence.
NANO-34

Water Vapor Extraction from Humid Air by Super-Hydrophilic VACNTs Growth on Stainless Steel Screen

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Vertically Aligned Carbon Nanotubes (VACNTs) are well known for easy obtainment and great possibilities of modification. Some functionalization methods allow making the VACNTs superhydrophilics. Super-hydrophilics surfaces have great potential for water collection from fog or any other humid gas mixture. In this work, we used the VACNTs wettability to separate water vapor from humid air. VACNTs were grown on stainless steel screen by thermal Chemical Vapor Deposition (CVD) method. The screens were previously oxidized in air at 650 °C. The growth process was performed without catalyst particles deposition. After this, we inserted the samples into a tubular CVD reactor working at 750 °C. An argon flow dragged the camphor vapor into the active zone. Functionalization step was carried out in a Microwave Chemical Vapor Deposition reactor. Oxygen functional groups were grafted on VACNTs surface by O2 plasma. An experimental arrangement was made to measure the VACNTs/steel screen collection efficiency. A humid air flow pass through VACNTs/steel screen. Super-hydrophilic VACNTs attract the water drops and drain the collected water to a recipient. Steel screen meshes and flow through the VACNTs/steel screen were varied. Morphologic and structural analyses were performed by Raman Spectroscopy, Scanning Electron Microscopy with Field Emission Gun (SEM-FEG) and X-Ray Diffraction. The samples wettability was verified by contact angle (CA) analyses. VACNTs superhydrophilicity was observed through the CA measurements. Water collect was successful performed. VACNTs/steel screen presented high sample area/collected water volume ratio.

NANO-35

Multi-walled Carbon Nanotubes Exfoliated by Hydrogen/Oxygen Plasmas and Their Performance in Supercapacitor Devices

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Charge-storage devices, such as supercapacitors, present high energy density and great power density, which can be improved by materials with a high surface area. Carbon nanotubes (CNTs) are known by their high active area, high electrical conductivity and chemical stability. These properties can promote better ions transportation, facilitating the double layer charging. CNTs exfoliation process is an interesting alternative to improve capacitive behaviour and surface area. In this work we report on the synthesis and electrochemical properties of exfoliated CNTs. We also present a new exfoliation method to produce CNTs/graphene oxide nanocomposite by hydrogen and oxygen plasmas treatments. CNTs were grown by thermal chemical vapor deposition at 700°C. For CNTs exfoliation, we used a microwave chemical vapor deposition reactor. We applied different treatment parameters to evaluate the exfoliation influence on capacitive behaviour. Oxygen plasma treatment was carried out aiming to simultaneously exfoliate and functionalize the CNTs. All samples
were characterized by Raman Scattering Spectroscopy, Scanning Electron Microscopy with Field Emission Gun (SEM-FEG), Fourier Transform Infrared (FTIR), X-Ray Diffraction (XRD) analysis, Contact Angle measurements and electrochemical analyses. SEM micrographs showed CNTs exfoliation, with the occurrence of open edges on their surfaces. In Raman spectra, we notice an increase in D band intensity after exfoliation process. By analyzing XRD patterns, we noticed a peak at 10° related to graphene oxide. We also observed the decrease in (002) peak intensity. FTIR spectra determined the influence of oxygen plasma as a functionalization process. For electrochemical assays two identical electrodes coated with CNTs/graphene oxide were placed in contact with each other, separated by an ion exchange membrane containing the electrolyte solution. Electrochemical analyses performed in a two-electrode cell device showed that exfoliation process increased the capacitive behaviour. Further, this nanocomposite showed itself to be a promising alternative for application in supercapacitor fabrication.

NANO-38(2)

High performance magneto-fluorescent nanoparticles assembled from terbium and gadolinium 1,3-diketones

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Noninvasive diagnostics provides in situ insight to the structural and functional features of the investigated systems and organs at their original place in the living organism. The use of magnetic and optical techniques is emerging for these purposes. Improved sensing in tissues, which in turn can differentiate normal tissue from diseased one, can be achieved by using magnetic contrast agents (CA) and optical emissive probes. f-Block elements (rare Earths) are outstanding candidates for this, since their chelates combine unique magnetic and luminescent characteristics. The precipitation of lanthanide complexes from water miscible organic solvents to polyelectrolyte-containing water solutions under effective stirring is an example of easy and effective synthetic pathway to embed large amount of lanthanide functional complexes to the nanoparticle. The synthesis of europium-doped luminescent polyelectrolyte colloids was first described four years ago [1] and later was applied to various terbium [2], and gadolinium [3] complexes.

NANO-38

Calix[4]arene-based Ln(III) 1,3-Diketonates as a Luminescent and Paramagnetic Functional Bricks to Construct a Novel Type of Nanoparticular Dual Contrast Agents

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Polyelectrolyte-coated nanoparticles consisting of terbium and gadolinium complexes with calix[4]arene tetra-diketone ligand were first synthesized[1]. The antenna effect of the ligand on Tb(III) green luminescence and the presence of water molecules in the coordination sphere of Gd(III) bring strong luminescent and paramagnetic performance to the core-shell nanoparticles [2, 3]. The size and the core-shell morphology of the colloids were studied using transmission electron microscopy and dynamic light scattering.

The correlation between photophysical and magnetic properties of the nanoparticles and their core composition was highlighted. The core composition was optimized for the longitudinal relaxivity to be greater than that of the commercial magnetic resonance imaging (MRI) contrast agents together with high level of Tb(III)-centered luminescence. The tuning of both magnetic and luminescent output of nanoparticles is obtained via the simple variation of lanthanide chelates concentrations in the initial synthetic solution. The exposure of the pheochromocytoma 12 (PC 12) tumor cells and periphery human blood lymphocytes to nanoparticles results in negligible effect on cell viability, decreased platelet aggregation and bright coloring, indicating the nanoparticles as promising candidates for dual magneto-fluorescent bioimaging.


NANO-39

Green Synthesis of Silver Nanoparticles From Callistemon Viminalis Flower Extract

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The biosynthesis (green chemistry) of nanoparticles has been proposed as a cost effective and environmentally friendly alternative to chemical and physical methods [1, 2]. We herein report on the green synthesis of silver nanoparticles using flower extracts of Callistemon viminalis plant. Silver was utilised as a metal precursor and it was found that the phytochemicals present in flower extract acted as a reducing and stabilizing agent. Spectroscopic and microscopic studies were conducted to investigate the optical and morphological properties of the silver nanoparticles for optics applications. Morphology and crystalline structure of the prepared silver nanoparticles were characterized by TEM and XRD techniques, respectively. The presence of a characteristic absorption band at a specific wavelength in UV–Vis revealed the reduction of silver metal ions into silver nanoparticles. FT-IR analysis was carried out to investigation the possible functional group involved in the synthesis of silver nanoparticles.
NANO-40

*Callistemon Viminalis* Extract Based Silver Nanoparticles Influence On The Optical Properties Of Porphyrin Nanorods

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In this present work, we used a developed green method for the synthesis of stable silver nanoparticles that does not require any of the conventional stabilizing ligands. The *Callistemon Viminalis* extract was used as a bioreductant and the polyphenols and flavanoids present in extract are responsible for the reduction of Ag\(^+\) ions to zero valent silver nanoparticles [1,2]. The successful formation of silver nanoparticles was confirmed by using ultraviolet–visible, transmission electron microscope and scanning electron microscope. Transmission electron microscope image analysis showed nanoparticles of various morphologies and X-ray diffraction plots provided information regarding the crystallinity of the nanoparticles. Silver nanoparticles where added to the porphyrin nanorods to produce composites and to enhance the optical properties of the nanorods.


NANO-41

Impact of Crystal Orientation and Conduction Band Non-parabolicity on Diffusion Constant of Nano-scale Si Rectangular Wires - theoretical estimation -

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Semiconductor wires are attracting attention as they offer low thermal conductivity [1]. Authors already estimated the diffusion constant of Si rectangular wires by assuming that the de Broglie wavelength can be applied to the decoherence length [2], and revealed that the assumption is acceptable given various past simulation results. In this paper, we address the significant impact of crystal orientation in estimating the diffusion constant of Si nanowires confined by (111) surfaces. Since the diffusion constant (\(D_{T,1D}\)) is calculated around room temperature, we adopt the following equation [2].

This calculation applies quantum-mechanical averaging to \(<v^2>\) because we must take account of the distinct electronic states of the onedimensional (1-D) system. For the case of confinement along the \(<111>\) direction, \(T-\) and \(<v^2>\) are roughly insensitive to the width; \(D_{T,1D}\) is insensitive to width in the above approximate equation. This characteristic is slightly impacted by the assumption of the non-parabolic conduction band. On the other hand, Si nanowires confined by (001) and (011) surfaces don’t show such interesting behavior.
Assessing the electrochemical performance of a supercapacitor electrode made of copper oxide and activated carbon using liquid phase plasma

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Successful modification of surface properties of a nanocomposite electrode is prerequisite to enhancing the overall performance of electrochemical supercapacitors. The present study was designed to describe the microstructural and electrochemical characteristics of a new composite electrode assembled by activated carbon (AC) powder (as a host) and copper precursor (as a guest) using liquid phase plasma. The fabrication processes were conducted by changing plasma discharge time from 30 to 90 minutes in the presence and absence of (thermal) oxidation. We observed that merging plasma and oxidation treatments raised the content of copper oxide nanoparticles precipitated (evenly) on the AC surface, along with oxygen. A mixed valence state of copper oxides (in the forms of Cu⁰, Cu₂O, and CuO) was found in different composites with and without oxidation, where CuO and Cu⁰ affected a specific capacitance in positive and negative ways, respectively. This led to the difference of electrochemical stability and resistance among the assembled composites. For instance, the best cycling performance was observed in the plasma-treated composite for 90 minutes with oxidation, whereas that of 60 minutes without oxidation recorded the lowest resistance. Therefore, a proper balance between the capacitance and resistance appears to be required for effective fabrication of the supercapacitor electrode, especially in cases involving copper oxides.

Effects of CeO$_2$ nanoparticles on electrochemical properties of carbon/CeO$_2$ composites

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Improved electrochemical properties of carbon were composited by formation with CeO$_2$ nanoparticles to attain high performance energy storage devices. Carbon was obtained from coffee husks by calcining at a temperature of 600°C for 1 h [1, 2]. Carbon/CeO$_2$ composites were prepared by mixture 0, 10, 20 and 30 wt% of CeO$_2$ nanoparticles as carbon, C/Ce10, C/Ce20 and C/Ce30, respectively. The carbon/CeO$_2$ composites were characterized by X-ray diffraction (XRD), Raman spectroscopy (Raman), transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS), Brunauer-Emmett-Teller (BET) and a potentiostat/galvanostat electrochemical cell system. XRD and Raman results exhibited the peaks corresponding to carbon and CeO$_2$, confirming the formation of a composite. The Ce$^{4+}$ and Ce$^{3+}$/oxygen vacancies were observed in all samples of carbon/CeO$_2$ composites. The specific surface areas were 216, 317, 340 and 270 m$^2$/g for carbon, C/Ce10, C/Ce20 and C/Ce30, respectively. The discharge capacity for electrodes made from carbon/CeO$_2$ composites showed an increase of approximately 2 times over those that from carbon. Higher discharge capacity was due to higher CeO$_2$ formation on carbon as well as the redox reaction Ce$^{3+}$$\leftrightarrow$Ce$^{4+}$ in the CeO$_2$ nanoparticles.


Characterization and Electrical Properties of BaTi$_{1-x-y}$(In$_{0.5}$Nb$_{0.5}$)$_x$Zr$_y$O$_3$ Ceramics

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BaTi$_{1-x-y}$(In$_{0.5}$Nb$_{0.5}$)$_x$Zr$_y$O$_3$ (x = 0.01 and y = 0, 0.05, 0.1) powders were prepared by solid state reaction method. The ceramic samples were sintered at 1400 °C for 3 h in air. All samples were characterized by X-ray diffraction (XRD), and X-ray absorption near edge structure (XANES). These ceramics exhibited tetragonal phase (y = 0, 0.05), and rhombohedral phase (x = 0.1) at room temperature. The XANES results showed that the intensities of pre-edge decreased with an increase in Zr concentration which corresponds to Ti off-centering. The dielectric and ferroelectric properties of ceramic samples were also investigated.
NANO-45

High resolution micro-resonators for chemo-selective sensing in liquids

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Fast and selective sensing of drugs or other solutes is a challenge for on-line analytics and control. A novel approach uses hydrogels via a templating procedure for solute specific recognition. A high resolution micro-resonator for mass sensing in liquids is functionalized with chemo-responsive hydrogels to offer a chemoselective response. The mass sensor consists of a bridge, whose torsional vibration mode is excited via electromagnetic Lorentz forces. Solely the integrated sensing plate (Ø=5 µm) is wetted by the solution, thus reducing damping. The adsorption of mass on the plate’s surface is monitored by the detection of the declining resonator frequency [1]. Functional hydrogels layers can change their mass through specific absorption of a solute or swelling depending on the environmental conditions (pH, ion strength, etc.). The challenge for such applications is the definition of gel micro-structures with UV lithography [2].

In a first approach a pH-sensitive hydrogel was immobilized on a cantilever sensor. Structuring of thin gel layers and the sensor was done simultaneously by reactive ion etching (RIE) using a thin gold or titanium layer as hard mask. In this way high aspect ratio gel microstructures were achieved instead of isotropic structures that are the common output of polymer etching with RIE. The process was technically feasible through continuous passivation of the polymer surface. In a second approach, multiphoton lithographic methods are assessed for structuring of molecular imprinted hydrogels. A detailed discussion on the manufacturing procedure, its actual validation and further developments will be addressed.


NANO-46

Hierarchical nano ZnO-microTiO₂ composite: high UV adsorption with photodegradation inhibition

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Nowadays, sunscreens are formulated by using TiO₂ and ZnO nanoparticles because they are efficient inorganic UV filters [1]. In fact microsized TiO₂ and ZnO have been increasingly replaced by TiO₂ and ZnO nanoparticles in order to solve the cosmetic drawback of the white opaque sunscreens apart from the higher yield that
nanoparticles suppose [2]. Also the aggregation state of the particles in sunscreens is related to the solar protection factor (SPF) of the final emulsion [3]. In this sense, dispersed nanoparticles into sunscreens increase the SPF value, but it means a possible leading to their incorporation into the stratum cornea, the outer layer of the skin. Moreover, when TiO₂ is irradiated produces free radicals which are implicated in a number of potential health issues such as skin aging because of the formation of reactive oxygen species (ROS) [4].

In this work, a new composite combining TiO₂ microparticles and ZnO nanoparticles has been achieved by using the sol-gel method. The presence of nanoparticles anchored over TiO₂ microparticles allows increasing the efficiency of nanoparticles but decreases the possible health problems by their absorption as nanoparticles. The combination of both oxides provokes higher SPF value and lower photodegradation, in comparison with TiO₂ microparticles. Moreover, the disposition of ZnO and TiO₂ particles means a positive synergy by the recombination of photo induced electrons holes, which decreases the formation of free radicals.


NANO-47

Design of nanostructured surfaces through the growth of 2D particles and its application as reflective materials

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In this work, Co₃O₄ nanoparticles were dispersed onto α-Al₂O₃ microparticles by using a patented dry dispersion method [1]. Further thermal treatment provides the formation of a nanostructured spinel CoAl₂O₄ layer onto α-Al₂O₃ giving rise to a core-shell composite. Thus, it is possible to avoid the toxic effects of the nanoparticles whereas their benefits about improving the functionality of the materials are still present in addition to reduce notably the amount of required cobalt. Moreover, solar reflectivity enhances by achieving values higher than 70% in the NIR range with the same chromatic coordinates than standard bulk pigments. These materials represent a step forward to design efficient and sustainable pigment that could act as cool pigment under solar radiation applications.

In the final product two mechanisms of CoAl₂O₄ crystallization onto α-Al₂O₃ microparticles surface are observed, depending on the dispersion grade of Co₃O₄. Hence, two different crystallization pathways could occur during the thermal treatment: 3D nanostructure from the arrangement of Co₃O₄ agglomerated nanoparticles; 2D nanoparticles from the diffusion mechanism of isolated Co₃O₄ nanoparticles. In order to understand the crystallizations mechanisms, a Raman Confocal Study was performed.
The dark colour of the cobalt species provokes red Raman shift due to the local heating, so it was performed a Raman study taking into account the temperature and the laser source power. We conclude that these variations are mainly owing to the different initial disposition of \( \text{Co}_3\text{O}_4 \) over \( \alpha-\text{Al}_2\text{O}_3 \) surface.


NANO-48

Characterization of Nanomaterials in Liquid Phase using Hyphenated Flow and Centrifugal Field-Flow Fractionation

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Size is crucial to developing nanotechnologies since it determines many of the physicochemical properties and functions of these materials. In addition, the European Commission has declared that a “nanomaterial” is a natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50% or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm–100 nm. According to this definition, not only the size but also the size distribution of nanomaterials in is an important factor for nanomaterial industrial field.

Field-flow fractionation (FFF) are elution techniques wherein nanoparticles, microparticles, and macromolecules are separated by their physicochemical properties. In nano- and micro-technology, various FFF methods are attractive techniques for separating materials in colloidal dispersions by means of flow, centrifugal, magnetic, and thermal field control. The most general applicable FFF methods are flow FFF and centrifugal FFF because of their practicality and the robust theoretical foundation established for separation of nano- and micro-materials in many areas.

Herein, a novel field-flow fractionation (FFF) separation system, a separation system hyphenated a flow FFF and a centrifugal FFF, was investigated as a hybrid tool for fractionation of nano- and micro-materials. The investigated FFF system makes it possible to separate materials with a considerably wider size distribution than is possible by either a flow FFF or centrifugal FFF alone. The hyphenated FFF separation system is also able to simultaneously separate materials by both hydrodynamic size and density. This investigated analytical method should play an important role in developing new applications of colloidal nano- and micro-materials in industrial and biological research.

Study of structure, optical and magnetic properties of Co-doped SrTiO$_3$ nanoparticles synthesized by hydrothermal method and first-principles calculation

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SrTiO$_3$ (STO) is an attractive material that offers a wide range of technological applications, e.g., ferroelectricity, solar cell and photocatalysis. Particularly, there has been a growing interest in using STO as a catalyst for photocatalytic processes because of its semiconducting feature, thermal stability and photocorrosion resistance. However, the band gap of this oxide corresponds to the UV light which is only a minor portion (around 4%) of the entire solar spectrum. This factor remarkably limits the photocatalytic performance of STO. To overcome the hindrance, a possible way to enhance the efficiency is to engineer the band gap in order to appropriately match the energy of visible and infrared light by means of introducing impurity. Also, we would like to improve magnetic property of STO by Ti site substitution by Co atoms. In this work, we present the structure, optical and magnetic properties of Co-doped SrTiO$_3$ via experimental and theoretical aspects. In the first-principles calculation, the structural properties, electronic band structure and magnetic properties of undoped STO and Co-doped STO supercells have been investigated by density functional theory using GGA with Hubbard model scheme (GGA+U) on Vienna Ab initio Simulation Package (VASP). In the same doping percentage of Co to calculation study, pure phase of STO with nanometer scale size of undoped STO and Co-doped STO have been synthesized using hydrothermal technique. The findings reveal that doping Co induces the new states in gap between the valence band and conduction band of STO. These impurity states narrow the band gap corresponding to experimental result. In addition, band splitting was observed on dopant systems indicating that doping Co on STO could induce magnetization on none magnetic material of STO. These results introduce that the Co-doped STO might be a potential candidate to be a photocatalyst for the high photocatalytic performance under visible light radiation and also could be applied as magnetic material.

Plasma Polymerized 2-methyl-2-oxazolyne Incorporated With Chlorhexidine for Biomedical Applications

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Plasma polymerized (pp-) thin films, are usually very adherent to any type of substrate and do not dissolve in mild acidic and basic media. Thus, polymers obtained by plasma from biocompatible monomers are very promising in the biomedical industry, such as drug releasing. In this work, a parallel plates reactor was used,
maintained at a low pressure and radio frequency power ranged from 1 to 20 W to deposit biocompatible nanometric thin polymer films by plasma, derived from 2-methyl-2-oxazoline monomer. The monomer was mixed with argon inside the chamber, the partial pressure was 50 and 30 mTorr respectively. Than the RF power source was then turned on and the deposition time was 1 hour. The wettability, molecular structure, thickness and roughness of the films were characterized.

In order to promote the drug incorporation, samples of all depositions conditions were dipped in chlorhexidine 2% for 30 minutes. Later, the samples were carefully rinsed in deionized water than flushed in compressed air and stored for 24 hours to dry. The surfaces treated with chlorhexidine were evaluated by its wettability, molecular structure and roughness. The process was also done in different ways, putting the chlorhexidine on the substrate and depositing the films on it, and incorporating the chlorhexidine in between two layers of the film.

It was observed influence on the deposition rate of the films, from 120 nm/h to 460 nm/h as the power increase from 5 to 20W. All the films presented hydrophilic and remained like this even after the chlorhexidine incorporation, with contact angles lower than 15 degrees. Changes in functional groups related to the chlorhexidine were observed in the infrared spectra after its incorporation, essentially C-C (1450-1512 cm⁻¹), C=N (1600-1670 cm⁻¹) and phenyl group (1550 cm⁻¹), the roughness decreased after the incorporation of the medicine.

NANO-52

Deposition of Diglyme Thin Films by Plasma Polymerization at Low Pressure Low RF Applied Power Conditions: Investigation of Polymerization Process

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Films deposited by plasma polymerization of diethylene glycol dimethyl-ether (diglyme) are known for its non-fouling characteristics, pinhole free, homogenized and cross-linked structures and resistance to acid and basic environments. In this work diglyme thin films were growth by plasma polymerization and their characteristics were studied by contact angle measurements (CA), FTIR, AFM and confocal microscopy (CM). These analyses were correlated with mass spectrometry and Langmuir probe plasmas diagnostics in order to investigate some polymerization mechanisms. The thin films were generated in a cylindrical stainless steel chamber reactor with two parallel plates electrodes excited at 13.56 MHz by a RF-power supply. The substrates were placed on the grounded electrode and discharges were carried out between 5 and 25 W. The pressure inside de chamber was varied from 10 to 26 Pa. The CA measurements showed hydrophilic surfaces and the water contact angle (WCA) was proportional to the applied power while the surface energy had opposite behavior. The surface roughness measurements, analyzed by AFM, noticed values between 0.9 and 1.5 nm and it was observed that rougher surfaces are generate at high values of applied power and operating pressure. The CM analyses showed that the deposition rate was between 45 and 145 nm/h with the same behavior of the roughness. The bonds C-O (1260-900 cm⁻¹) and C-H (3000-2800 cm⁻¹) were analyzed by FTIR and the integrated absorption calculus reveals that C-H/C-O ratio decreases with the applied power. The ionized species studied by mass spectrometry were CH₃⁺ (m/z = 15), CH₂CH₂⁺ and/or CO⁺ (m/z = 28), CH₃O⁺ (m/z = 31), CH₂CH₂O⁺ and/or CH₂OCH₂⁺ (m/z = 44), CH₃OCH₂CH₂⁺ (m/z = 59) and CH₃OCH₂CH₂O⁺ (m/z = 75). It was observed that the ratio between smaller species and ions with high m/z ratio increases with the applied power. The same behavior was observed in the electron temperature that ranged from 0.53 eV to 1.95 eV.
Micro-octahedra of Cu$_2$O: Hydrothermal synthesis and electrochemical properties

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Much work has been devoted to the controlled morphology synthesis of inorganic materials either at the nanometer or micrometer scales. The obtained various typical morphologies present different properties. Among of these materials, we can cite cuprous oxide. It is inexpensive and non-toxic with a narrow band gap of 2.17 eV at room temperature. Owing to its unique physicochemical properties, this material has a wide range of applications especially solar energy conversion [1] and lithium batteries [2]. In this work, we describe the synthesis of Cu$_2$O microcrystals with various shapes obtained by reducing copper nitrate with hydroquinone which, acts as a reducing and structure-directing agent. The electrochemical properties of the Cu$_2$O micro-octahedra have been investigated using the cyclic voltammetry. This study showed that this phase exhibits remarkable electrochemical performances.


One-step Hydrothermal Method to Fabricate Drag-reduction Superhydrophobic Surface

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Inspired by the lotus leaf, various methods to fabricate superhydrophobic surface has attracted considerable attention$^{[1,2]}$, such as chemical etching, laser micromachining, electrodeposition method, etc. In this paper, we present a novel, environment-friendly and one-step method to fabricate a superhydrophobic surface on an aluminum substrate. The aluminum substrate was immersed in a mixed solution containing aluminum oxide (Al$_2$O$_3$), perfluorotetradecanoic acid (CF$_3$(CF$_2$)$_{12}$COOH), deionized water and ethanol. After hydrothermal synthesis in a high pressure autoclave at 150°C, a superhydrophobic surface was obtained. The morphologies and chemical compositions of the as-prepared sample were characterized by scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS) and energy-dispersive spectroscopy (EDS). The lamellar structure film was formed on the aluminum surface through two step reactions: the first was hydrolysis reaction of Al and Al$_2$O$_3$ to generate AlOOH and Al(OH)$_3$, the second was neutralization reaction to generate Al[CF$_3$(CF$_2$)$_{12}$COO]$_3$ with low surface energy. As the duration of the hydrothermal synthesis was increased, more of the lamellar structures were formed on aluminum surface. When the reaction time is 1h, the as-prepared sample exhibited well superhydrophobic property. The contact angle (CA) is about 158° ±2°, and the sliding angle (SA) is less than 3.5° ± 0.5°. Furthermore, the superhydrophobic surface showed self-cleaning and drag-
Preparation and drag reduction of porous superhydrophobic surface on stainless steel

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Superhydrophobic surfaces have attracted much attention recently in fundamental research and potential industrial applications, such as drag reduction, non-adhesion, microdroplet transportation, and anti-fogging[1,2]. In general, it is very difficult to fabricate an applicable engineering superhydrophobic surface on stainless steel, because the textured films easily fall off the stainless steel substrate. In this paper, the porous surface with micro/nanoscale hierarchical structure was obtained by anodizing 304 stainless steel foil in electrolyte containing 5 wt% perchloric acid in ethylene glycol at room temperature. The electrochemical oxidation of iron was based on the fact that metal etching is formation and dissolution of its oxide by the perchloric acid. The ethylene glycol has proven to be the most effective electrolytic medium in rapid synthesis of iron (III) oxide nanoporous structure in potentiostatic anodization of iron. After the modification with silane regent, the wettability of the as-prepared sample is successfully converted from superhydrophilicity to superhydrophobicity. The water CA for the sample surfaces is 158 ± 2°, and SAs is less than 4±2°. We investigate the drag reduction of the prepared 304 stainless steel surface. The superhydrophobic surface has enormously improved the drag reduction ratio of the stainless steel foil, at approximately 30%-40%. Bearing this in mind, we construct superhydrophobic surfaces that have numerous technical applications in drug reduction field.

Effect of Ordered Mesoporous Structure Adoption in Thermoelectric Oxides

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Ordered mesoporous materials have a structure containing nano-sized pores. The pore size, pore distribution (regular/irregular, open/close), and pore shape can be controlled easily according to the synthesis process. The existence of pores inside the material grants distinctive properties such as decreased dielectric constant from increased porosity and decreased thermal conductivity from increasing phonon scattering. Therefore nanoporous materials can be used in many applications such as thermal insulators, low dielectrics, thermoelectrics, and so on. The efficiency of a thermoelectric is determined by its dimensionless figure of merit, $Z = \frac{S^2\sigma}{\kappa}$ where $S$, $\sigma$, and $\kappa$ are the Seebeck coefficient, electrical conductivity, and thermal conductivity, respectively. According to this equation, good thermoelectric material should possess large power factor ($PF = S^2\sigma$) and low thermal conductivity. Recently, an application of metal oxides to thermoelectric materials has been progressed for the enhancement of cost-effective and thermal stability. Among them, La-doped SrTiO$_3$/SrMnO$_3$ (LSTO/LSMO) have been focused greatly because these materials have good conductivity and thermal stability. However LSTO/LSMO have small Seebeck coefficients and high thermal conductivities compared with other thermoelectric materials. So, LSTO/LSMO need an enhancement of Seebeck coefficient and a reduction of thermal conductivity while maintaining electrical conductivity for applying to thermoelectric material. So, in this presentation, we applied nanoporous structure to LSTO/LSMO to enhance the thermal insulating property.


On the determination of growth stress during oxidation of pure zirconium at elevated temperature

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During oxidation of metals various chemical, mechanical and thermal processes appear. Among numerous phenomena, one can choose to investigate growth stress which arises during oxidation and thermal strains which are related to the differences in coefficients of thermal expansion between metal and oxide. In order to better define these mechanisms and its consequences, an experimental approach, based on previously reported by Przybilla et al. [1] technique has been implemented.

An experimental and numerical method is proposed to evaluate the growth stress between a metal and its oxide. The development of growth stress in oxide scale on pure zirconium has been investigated experimentally by combining the deflection test in monofacial oxidation (DTMO) with acoustic emission analysis (AE). The investigations were performed for 24 h at 400 °C and 500 °C in air under normal atmospheric pressure. First,
the assumption of elastic behaviour led to primary evolution of growth stress. Then, results of this study were used in a thermo-mechanical simulation of the oxidation process of zirconium [2]. Presented study of the Zr/ZrO₂ system revealed two opposite phenomena of stress relief when cooling from respectively, 400 °C and 500 °C to room temperature. This study is presented as a tool to understand the phenomena of stress accumulation in the zirconia layer during isothermal treatment at high temperature and after cooling when thermal strains appear.


NANO-59

Evaluation of consolidation method on mechanical and structural properties of ODS RAF steel

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Reduced Activation Ferritic Oxide Dispersed Strengthened (ODS RAF) steels are novel materials characterized by: excellent mechanical properties, high corrosion resistance, stability in radiation environment and in high temperature [1]. For this reason, ODS steels are considered as the most promising candidates for future nuclear application (i.e. elements of IV gen. reactors). Combination of these unique properties is an effect of presence of specific elements equally distributed in the microstructure i.e.: nano-precipitates of Y-Ti-O or Y-Al-O, and high density of dislocations [1,2]. Although addition of Y₂O₃ has been proved to be advantageous for mechanical properties, it complicates fabrication methods making traditional production processes unsuitable. Thus, ODS steels are fabricated by means of mechanical alloying (MA) processes and different powders consolidation methods.

In present work, effects of fabrication method on mechanical and structural properties of 12%Cr, 2%W, 0,25%Ti, 0,25%Y₂O₃ steel were investigated. Materials obtained by using Spark Plasma Sintering (SPS), Hot Isostatic Pressing (HIP) and Hot Extrusion (HE) methods were studied. The microstructure was characterized by using High Resolution Scanning Electron Microscopy (HR-SEM) and Electron Backscatter Diffraction Analysis (EBSD). Mechanical properties were evaluated by using Vickers micro-hardness HV0,1, Small Punch Test (SPT) and nano-indentation methods (NI). Conducted research shows that samples after HIP and SPS processes exhibit very similar properties, whereas the first technique provide slightly higher values of hardness. In addition, significantly lower mechanical properties of the specimens after HE process were observed. Finally, reported herein studies tackle the problem of comparison of mechanical parameters measured in micro- and nano-scale experiments.

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Vanadium oxides and their related compounds have been investigated both extensively and intensively due to their novel physicochemical properties and potential applications in lithium Batteries [1]. The layered structure and redox ability of vanadium oxides allow the insertion of various guest species such as polymers, leading to the formation of hybrid materials with a mixed valence of vanadium (V⁴⁺/V⁵⁺) [2]. Organic–inorganic hybrid structures have been designed to achieve new materials with improved properties because of the synergic effects of their constituents at a molecular level. Specifically, the intercalation of conducting polymers into layered inorganic hosts has been a topic of research interest over the past half century [3].

Herein, we report an efficient method for the controlled fabrication of amino-alcohol-intercalated layered vanadium oxide nanocomposites via a facile one-pot hydrothermal route. The effects of the reaction temperature and time on the structure and morphology of the resulting product were discussed in detail. Moreover, the potential application of the resulting layered nanocomposite in the lithium battery was investigated.


Anti-Icing Nano-Composites

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Anti-icing coatings have been in great demand in applications which stimulated scientific studies to develop new material systems having anti-icing functionality and to understand their anti-icing mechanisms [1]. Whilst superhydrophobic surfaces incorporating micro/nanoscale roughness have been proven to prevent ice accumulation under certain conditions, the same roughness can be detrimental in other environments. Surfaces
with a smooth liquid interface can eliminate some of the drawbacks of textured superhydrophobic surfaces, but additional study is needed to fully realize their potential. In this work, we propose the use of smart stimuli responsive anti-icing coating that releases the anti-icing agent slowly when exposed to water. These composite coatings are built up of anti-icing agent loaded porous silica based particles dispersed in a polymer matrix. As a result of the release of anti-icing agent from the porous particles upon contact with water, the freezing temperature of the water droplets decreased significantly and substantial freezing delay was observed. Water droplet freezing results showed that these coatings delayed freezing by as much as 550 s at -12°C compared to uncoated substrates. The coatings are highly stable and preserving a continuous anti-icing agent release to the top surface even if damaged by scratches. These coatings have the great advantage of being reloaded by the anti-icing agent several times.


**NANO-63**

**The calculation electronic and optical properties of the C, Si, SiC and SiGe quantum dots**

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The hydrogen-terminated C, Si, SiC and SiGe quantum dots were modeled based on diamond and zinc-blend structure, respectively, with different diameters (called dot2, dot3 and dot4). The optimized structure, optical absorption energy of these dots were studied by DFT and the exited states were then calculated by using time-dependent density functional theory (TDDFT) with (B3LYP) hybrid functional. The results show that the calculated structures these hydrogen-capped nano-crystals are almost spherical shaped. For the optical properties, these quantum dots show tuneable absorption energy, depending on particle size, and the larger particles have lower absorption energy. The HOMO-LUMO energy level is decreasing when the diameter of these dots is increased. The investigated the absorption energy shows peak in UV-vis range and red shift. The position energy absorption will be increase when diameter of the quantum dot is increasing.

Oxygen adsorption over graphene/GaN (0001) surface

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Interactions between graphene or its oxide with GaN, have shown experimentally that could reduce the operational temperature at which transistors, LED’s and high potency diodes works [1,2]. The graphene oxide is a very promising material for its own properties and for its use in the production of graphene by reduction. However theoretical papers that describe the underlying physics are scarce. In previous works we estimated the feasibility of a graphene monolayer grew over GaN(0001) surfaces[3] In this work we will present Density Functional Theory (DFT) calculations, of the surface structure resultant from introduction of oxygen on a monolayer of graphene to obtain a graphene oxide monolayer. The unit cell used was $\sqrt{3} \times \sqrt{3}$ graphene/4x4(0001)GaN. First of all we considered the adsorption of a single oxygen atom over the carbon atoms, which are no equivalent due to their interaction with the Ga and N atoms of the substrate. The sites considered are: over Ga or N atoms, between two Gallium atoms, and some other sites. The total energy calculations show that the position between two Ga atoms is the preferred adsorption site. Then we introduce more oxygen atoms up to four by unit cell. The introduction of oxygen favors the match among the surfaces and the system changes its metallic character to a semiconductor one in relation to the oxygen content. Finally we studied the adsorption of hydroxyl groups and different combinations of hydroxyl and oxygen. The results obtained seem to indicate that this could be a good method to fine tuning the gap.

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Photodynamic Chemotherapy Using ROS-degradable Polymer Nanoparticles to Enhance In vivo Drug Efficacy

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Despite the impressive effects of drug delivery nanoparticles in vitro, limited in vivo benefits have hindered their clinical applications. Well-designed targeting and controlled release capabilities of nanoparticles are often compromised because of complex in vivo situations. Here we introduce a new concept of remote activation of tumor-targeted nanoparticles to increase anti-cancer therapeutics in vivo by implementing photodynamic effects
within reactive oxygen species (ROS)-degradable polythioketal micelles incorporating photosensitizers. The polymer micelles were fabricated from the self-assembly of the amphiphilic block copolymer of poly(1,4-phenyleneacetone dimethylene thioketal) (PPADT) and polyethylene glycol (PEG). TPP and paclitaxel were encapsulated within PEG-b-PPADT micelles, whereby folic acid was decorated on the surface of the micelles by incorporating folic acid-PEG-b-PPADT. HeLa cells were treated with the micelles at various concentrations of paclitaxel and exposed to visible light illumination (650 nm, 70 mW/cm²) for 20 min. The intravenous injections of the micelles with a low paclitaxel dosage (1 mg/kg), followed by visible light illumination on tumor sites were performed. Localized irradiation of visible light to the nanoparticles targeted to tumor sites selectively activates boosted release of anti-cancer drugs. Studies using a xenograft tumor mouse model demonstrated that the in vivo therapeutic effects are very efficiently controlled by light illumination. Our study suggests that the ROS-sensitive degradable polymeric nanoparticles can be used as a new promising platform for light-controlled delivery of anti-cancer therapeutics.


NANO-66

Simulations of Hydrogen Storage Capacities of Activated Carbons using Interaction Potentials that include Dispersion Interactions

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Simulations of the hydrogen storage capacities of activated carbons require an accurate treatment of the interaction of a hydrogen molecule physisorbed on the graphitic-like surfaces of activated carbons, which is dominated by the dispersion forces. The simulated hydrogen storage capacities depend on the shape of two regions of the interaction energy curve of H₂ on a graphitic-like surface: The region around the minimum and the tail region, the region far from the carbon surface. This second region is especially important in the case of the simulation of the storage capacities of wide pores [1]. The dispersion interactions are described accurately by high level quantum chemistry methods, like the CCSD(T), but those methods are computationally very expensive for large systems and for massive simulations. DFT-based methods that include dispersion interactions at different levels of complexity are less accurate, but computationally less expensive. Calculations of the interaction potential energy of H₂ physisorbed on benzene and graphene as a function of the H₂-benzene and H₂-graphene distance r have been carried out using the CCSD(T) and MP2 methods, and DFT-based methods that include the dispersion interactions. The obtained interaction potential energy V(r) for each method has been used with a quantum-thermodynamical model of the physisorption of H₂ on surfaces [2], to calculate the gravimetric and volumetric capacities of activated carbons, simulated as benzene and graphene slit-shaped pores, as a function of pressure, temperature and pore width. The effect of the dispersion interactions on the calculated storage capacities, through the interaction potentials V(r), is studied and evaluated.

NANO-67

Carbon nanomaterials as glassy carbon modifiers for electrochemical devices with boosted activity
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The glassy carbon electrode (GCE) is popular in electroanalysis for its wide potential range, low cost, availability, and chemical inertness in most electrolytes. However, during the oxidation of many analytes the reproducibility and sensitivity of its response deteriorate due to the fouling of its surface [1]. Carbon nanotubes and more recently graphene have attracted a great deal of attention [2], especially in the field of chemically modified electrodes due to their ability to promote electron-transfer processes. Due to the relevance of dopamine and catechol in clinical and environmental fields we investigated their electroactivity at a GCE modified with a composite made of multi-walled carbon nanotubes and electrochemically reduced graphene oxide demonstrating the significant improvement of the analytical performances. The same composite was used to support tyrosinase or laccase to fabricate amperometric biosensors for determining total polyphenols in juice samples, based on the reduction of the enzymatically produced quinone. Carbon based nanomaterials can also be used to induce the electrosynthesis of anionic clays, such as layered double hydroxides (LDHs). LDHs have been extensively investigated for a lot of electrochemical applications, especially for energy storage and sensing. The LDH electrosynthesis has the advantage to generate in situ films displaying a good adhesion to the support in a very short time [3]. Using glucose as target, electrocatalytic activity was found to be higher than when LDH was deposited on bare GC.


NANO-68

Green Synthesis of SmPO$_4$ Nanomaterials via *Callistemon viminalis* Extract
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Lanthanide phosphates nanomaterials have been industrially relevant since the end of the nineteenth century and are reported to have diverse applications such as in the fields of luminescent materials [1], nuclear waste treatment [2] and superhydrophobic materials [3]. In the past decades, attention has been focussed on their preparation, characterization and application due to their very interesting unique chemical and physical properties such as very high thermal stability ($\sim$2300 °C) and low solubility ($K_{sp} = 10^{-25} - 10^{-27}$) in water. These
unique properties can be controlled by the morphology and size of the nanomaterials which in turn can be controlled by fine-tuning parameters such as methods of synthesis. Many methods such as sol-gel [4] have been used to successfully synthesize lanthanide phosphates in different nano-sizes and shapes. However, these methods are expensive (high temperature), involve the use of hazardous materials and lengthy synthesis times. We report for the first time the biosynthesis of SmPO₄ nanomaterials using an aqueous extract from the red flowers of *Callistemon viminalis*, a plant common in certain parts of South Africa, at room temperature. There was no use of inorganic, organic solvents or surfactants in this method of synthesis making it environmentally friendly. Their structural and optical properties by electron microscopy, infrared, powder XRD and Raman are reported.


**NANO-71**

**Sputtering Yield in Nanowires**

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The bombardment of different [101] Co nanowires with 1-keV argon ions is simulated by molecular dynamics. The aim of this article is to analyze the dependence of sputtering yield (number of atoms ejected from the target per argon ion) on curvature of surface and size. Nanowires are bombarded along the [010] direction. This election allows us to contrast results with previous bombardment simulations on {100} nanosurfaces. Different cross-section shapes, and therefore, different curvatures of surface, were used for nanowires: square, circular, and rhomboid. Some works [1] point out that yield increases for impact on convex surfaces. Besides, different cross-section sizes were also considered. Sputtering yield decreases with increasing this quantity until an asymptotic value is reached. Simulation experiments have been carried out at low dose to avoid a great surface damage. In fact, for small sizes, nanowire could break and divide into two parts. Dislocation movement can also produce deformations in the bombardment zone. All results were compared with analytical values obtained by the Sigmund model. This model considers that sputtering yield is proportional to the deposited surface energy. Besides, it predicts a maximum for sputtering yield as a function of size and an asymptotic behavior when the nanowire tends towards a bulk system. Simulations and analytical results coincide in this range. The angular distribution shows that the lattice structure determines the directions of ejection. In fact, <110> directions are the favorite emission directions of atoms target. Besides, ejection in the bombardment direction decreases with decreasing the nanowire size.

NANO-72

Crossover from compact to branched films in electrodeposition with surface diffusion

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We studied a model for thin film electrodeposition in which the instability development by preferential adsorption and reduction at surface peaks competes with surface relaxation by diffusion. The model considers diffusion-limited aggregation of cations from a supported electrolyte and formation of mobile ad-particles after their reduction. The activated surface diffusion of this ad-particle is represented by a sequence of random steps to neighboring lattice sites with a maximum of $G$ step trials ($G \gg 1$), a detachment probability $\varepsilon < 1$ per neighboring particle, and a no-desorption condition. Computer simulations of large deposits show the formation of a compact layer followed by the growth of branched deposits. The maximal thickness $z_c$ of that layer increases with $G$, but is weakly affected by $\varepsilon$. A scaling approach describes the crossover from smooth film growth to unstable growth and predicts $z_c \sim G^\gamma$, with $\gamma = 1/[2(1-\nu)] \approx 0.43$, where $\nu \approx 0.30$ is the inverse of the dynamical exponent of the Villain-Lai-Das Sarma equation that describes the initial roughening. Using previous results for related deposition models, the thickness $z_c$ can be predicted as a function of an activation energy for terrace surface diffusion and the temperature, and the small effects of the parameter $\varepsilon$ are justified. These predictions are confirmed by the numerical results with good accuracy. We discuss possible applications, with a particular focus on the growth of multifunctional structures with stacking layers of different porosity.

NANO-73

Effects of film growth kinetics on grain coarsening and grain shape

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We study models of grain nucleation and coarsening during the deposition of a thin film using numerical simulations and scaling approaches [1]. The incorporation of new particles in the film is determined by lattice growth models in three different universality classes, with no effect of the grain structure. The first model of grain coarsening is similar to that proposed in Ref. [2], in which nucleation occurs only at the substrate, and the grain boundary evolution at the film surface is determined by a probabilistic competition of neighboring grains.

The surface grain density has a power-law decay, with an exponent related to the dynamical exponent of the underlying growth kinetics, and the average radius of gyration scales with the film thickness with the same exponent. This model is extended by allowing nucleation of new grains during the deposition, with constant but small rates. The surface grain density crosses over from the initial power law decay to a saturation; at the crossover, the time, grain mass, and surface grain density are estimated as a function of the nucleation rate. The distributions of grain mass, height, and radius of gyration show remarkable power law decays, similar to other systems with coarsening and particle injection, with exponents also related to the dynamical exponent. The scaling of the radius of gyration with the height $h$ relative to the base of the grain show clearly different
exponents in growth dominated by surface tension and growth dominated by surface diffusion, thus it may be interesting for investigating the effects of kinetic roughening on grain morphology. In growth dominated by surface diffusion, the increase of grain size with temperature is observed.


NANO-74

The Role of Nanocoating and Fluid PH Level on the Enhancement of Surface Hydrophobicity Behaviour

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Experimental investigation was performed to highlight the influence of ionic bounding’s and surface roughness effect on the surface wettability between the substrate and the fluid in contact to it [1-2]. Nanocoating technique via physical vapor deposition (PVD) process was used to fabricate Aluminum (Al) film of 100 nm, which was deposited on the surface of an Al sample of 25 mm diameter by 15 mm height. Microstructures of the samples before and after deposition were observed by using an atomic force microscopy (AFM). A goniometer devices was later used to examine the influence of surface topography on deionised waters of PH 4, 7 and 9 droplets through their contact angles with the substrate surface, for both coated and uncoated samples. It was found that although the coating has reduced the surface roughness of the sample from 0.5 µm to 0.25 µm, by filling part of the microstructure gaps with Al nanoparticles, the wettability was mostly effected by the ionic bounds between the surface and the free anions (OH-) and cations (H+) in the fluid. As the deionised water of PH 7 gave an average contact angles of 60° and 42.6° for both uncoated and coated sample respectively. While reducing the PH to 4, by adding HCL, gave an average contact angles of 63.5° and 107.7° and increasing it to 9, by adding NaOH, gave an average contact angles of 77.56° and 106.74° for the same previous samples order. The results from this approach clearly shows that nanocoating significant endorse the hydrophobicity (unwitting) effect between the surface and the fluid by modifying the PH level of the fluid. These findings are substantially attractive for a variety of applications such as airplane wings, power plants, desalination plants, and even electronics when implemented in their system design [3].

NANO-75

Synthesis of surface-modified superparamagnetic nanoparticles by PEG-400 to embedding Ag and Au nanoparticles as antifungal agents.

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Intelligent drugs such as those controlled by magnetic forces could open a new horizon to overcome drug resistance. It has been shown previously that Ag and Au nanoparticles have considerable antimicrobial activities. Hence, combination of these nanoparticles with Iron molecule could help one to guide the molecule to the infected area. In present study, we carried out chemical synthesis and characterization a Fe3O4@PEG-Ag and Fe3O4@PEG-Au nanocomposites which prepared as a core/shell nanostructures. Moreover, antifungal activities of these molecules against some pathogenic fungi were determined.

Fe3O4 nanoparticles were synthesized by co-precipitation of bi/trivalent iron ions. So poly ethylene glycol (PEG) added as a shell on the surfaces of nanoparticles. Finally, Ag and Au ions reduced on the nanoparticles to synthesis Fe3O4@PEG-Ag and Fe3O4@PEG-Au, respectively. Nanostructures were characterized with FT-IR, FESEM-EDS, VSM, TEM and AFM. The compounds were evaluated for their antifungal activity against A.fumigatus, A.clavatus and A.flavus and Candida species based on M27-A2 and M38-A protocols as recommended by CLSI. Newly synthesized compounds exhibited good antifungal activity, as they could inhibit the growth of the tested fungi at concentration of 16-64 μg/mL. Ag particles showed better activity than Au particles. Concentration of these nanoparticles could be increased by magnetic force. Therefore, these novel compounds with antifungal properties might be used for treatment of localized infection and invasive aspergillosis and candidiasis in specific location or tissue by magnetic fields.

NANO-76

Effect of various electrolytes on the electrochemical properties of Ni(OH)2 nanostructures

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Hexagonal nanoplates of Ni(OH)2 with a thickness of ~ 11 nm were synthesized by a simple hydrothermal method. The formation of Ni(OH)2 phase was confirmed by XRD technique. TEM images revealed a stacks of hexagonal nanosheets with average nanoplates size of ~ 62 nm. XPS results confirmed the elemental compositions at the surface of Ni(OH)2 which are in good agreement with XRD results. As we known, the properties of electrolyte affect the performance of supercapacitor. Therefore, the electrochemical performance
of Ni(OH)$_2$ electrodes were investigated in various aqueous electrolytes solution including 1M NaOH, 2M KOH, and mixed of 1M KOH with 0.5M Na$_2$SO$_4$. The electrochemical results showed that Ni(OH)$_2$ electrode in 1M NaOH electrolyte reached the highest specific capacitance of 447 F/g at current density of 1A/g that was nearly two times higher than in 2M KOH electrolyte. This can be attributed to the smaller ionic radius of Na$^+$ ion and a higher intercalation/deintercalation rate of Na$^+$ ions into the surface of Ni(OH)$_2$ electrode. In addition, coulombic efficiency of 94% was found in 1M NaOH at a current density of 10 A/g. The capacity retention of Ni(OH)$_2$ electrode in 1M NaOH was maintained at about 100% after 1000 cycles. The present work proves that the best performance of Ni(OH)$_2$ nanoplates was performed in 1M NaOH electrolyte.

**NANO-77**

**Synthesis, Characterization and Gas Sensing Properties of Cadmium Tin Oxide Nanoparticles**

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Since last decade synthesis and characterization of composite metal oxides nanostructures and finding their new applications has become an active research field. Cadmium Tin Oxide (CTO), cadmium stannate is one of the promising composite oxide system among other composite oxides like ITO, FTO, ZTO, etc. because of its peculiar and interesting optical and electrical properties. CTO system usually forms two polymorphs namely as mono and di cadmium stannate CdSnO$_3$ and Cd$_2$SnO$_4$ respectively and both are good transparent semiconductor oxides. There wide optical band gap and good conductivity make them very useful material for the applications such as a TCO substrate in solar cells, gas sensors, photoanode material for solar water splitting system, biodegradation process [1-4].

Herein we have synthesized pure single phase orthorhombic Cd$_2$SnO$_4$ and rhombohedral CdSnO$_3$ nanoparticles by chemical methods. The structural, morphological and optical properties of the synthesized nanoparticles are investigated using techniques such as X-ray diffraction, FESEM, EDX, TEM, UV-Visible, and Raman spectroscopy. Synthesized Cd$_2$SnO$_4$ nanoparticles by one step solution combustion method using stannous chloride and cadmium nitrate as precursor and citric acid is used as fuel. Synthesized nanoparticles are found to have orthorhombic phase with cubical shape particles with edge length around 20 nm and UV-Visible spectroscopy measurement confirms there band gap is 3.3 eV. The gas sensing properties of the synthesized nanoparticles at three different temperatures for volatile organic compounds (VOC) vapours and ammonia gas. Our study suggests that the orthorhombic phase Cd$_2$SnO$_4$ has better sensitivity and response time for propan-2ol gas against the other gases.

Development of Radiation Curable Nanocomposites for Coating Applications

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Radiation curing is one of the most effective processes to produce rapidly composite materials at ambient temperature. Silica nanoparticles can be introduced into radiation curable resins to produce scratch and abrasion resistant materials, which can be used in coating applications. In preparation of radiation cured polymeric nanocomposites for wood based products, we synthesized radiation curable organic-inorganic nanoparticles from silica/acylates system. These nano-sized silica particles were used as fillers. Epoxy acrylates was used as prepolymer while pentaerythritol triacrylate (PETIA) was used as monomer. The epoxidized acrylate resin synthesized from palm oil based product (EPOLA) i.e. bio-renewable raw materials was also used in the system. The surface of the silica was chemically modified to improve the embedding of the filler within the acrylate matrix. Modification of the silica surface was done by heterogeneous hydrolytic condensation reaction to overcome the problem of incompatibility with acrylates at high silica contents. In these investigations, ultraviolet (UV) light and electron beam (EB) radiation were used to cure coating materials containing different proportions of nanoparticle (SiO$_2$), the influence of various factors such as different type of photoinitiators and other additives in the formulations were also been investigated. The cured films were characterized by gel fraction and swelling techniques. The effect of nanoparticles on the performance and properties of the cured coating such as pendulum hardness, scratch and abrasion resistance were also been determined. The nanoparticle induced both a bulk and a surface modification of cured coatings with an increase gel content and surface hardness by increasing the amount of silica into the radiation curable resin. The strong decrease on water uptake in the presence of SiO$_2$ makes these nanocomposites particularly interesting for our investigation.

**NANO-80**

**Synthesis and Electrochemical Properties of Ni-doped MnCo$_2$O$_4$ Nanoparticles Prepared by a Simple Polymer Solution Method**

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Mn$_{1-x}$Ni$_x$Co$_2$O$_4$ (x = 0, 0.05, 0.1, 0.15, 0.2) nanoparticles were prepared by a simple polymer solution method using polyacrylonitrile (PAN) as a polymer source and Mn and Co nitrates as metal sources. The prepared precursor was calcined 600°C for 2 h. The calcined samples were characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM), and X-ray absorption near edge structure (XANES). The electrochemical performance of these Mn$_{1-x}$Ni$_x$Co$_2$O$_4$ nanoparticles as a supercapacitor was investigated by using a three-electrode cell system in 6.0M KOH electrolyte. The results show that the highest specific capacitance of 289 F g$^{-1}$ at 1.0 A g$^{-1}$ were obtained for Mn$_{0.8}$Ni$_{0.2}$Co$_2$O$_4$ nanoparticles and a good capacity retention of 70.3% after 1000 continuous charge-discharge cycles. The excellent capacitive properties and stability suggest that the Mn$_{0.8}$Ni$_{0.2}$Co$_2$O$_4$ nanoparticles could be promising electrode materials for supercapacitors.

**NANO-81**

**Metal-free polyphtalocyanine – 2D conductive polymer**

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After the discovery of graphene the scientific community is carrying out active research of its analogs – 2D conductive polymers. Polyphtalocyanines (PPCs) are a unique class of organometallic compounds, having a number of unique properties [1], which make them very promising material for semiconductor technology, electrochemical and gas sensors, organic light emitting diodes, catalysts. PPCs are also a potential base for spintronic devices [2]. At present, several groups have attempted to synthesize the PPC thin layers, but structurally uniform films with a high polymerization degree were not obtained. Earlier we reported a new route to the synthesis of copper PPC thin films through the two-zone chemical vapor deposition [3]. This approach is suitable for metal-free polyphtalocyanine (H$_2$PPC) synthesis on Mo-doped surfaces, since it is known that molybdenum can catalyze the PPC formation without the incorporation in the polymer. For the practical applications, H$_2$PPC is likely to be of the highest value, because two hydrogen atoms should undergo easy substitution by a large number of metals. This gives an approach to make an universal polyphtalocyanine matrix.
The results of infrared and X-ray photoelectron spectroscopy, as well as transmission electron microscopy shown that in this way H$_2$PPC films of high uniformity and high polymerization degree can be obtained. The proposed method is highly promising for obtaining films, which can be used in optics, catalysts and sensors. This work was supported by Russian Foundation for Basic Research (project no. 17-73-10128).


**NANO-82**

**Electron beam assisted chemical vapor deposition of 3D carbon structures**

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At present, the chemical vapor deposition (CVD) is one of the most popular methods of carbon materials and various semiconducting thin films obtaining. Therefore, the search for tools to control the CVD process is an actual problem. It is known that the state of the substrate is one of the factors influencing the thin films deposition. In the present work, we describe the influence of e-beam irradiation of the SiO$_2$-layer on the process of carbon structures obtaining.

We were the first who found that a preliminary e-beam exposure of the substrate strongly affects the rate of graphene-like films deposition on dielectrics [1]. It should be noted that this effect is not related to the carbon contamination, which can be formed on the sample surface in scanning electron microscope during electron exposure. The effect is a complicated phenomenon. At the present time, the influence of a preliminary e-beam exposure of the substrate on the graphene-like films growth can be assumed to arise as a result of charging the substrate. The magnitude of the accumulated charge can also affect the synthesis and properties of the carbon structure. Therefore, SiO$_2$ substrate was further irradiated by electrons with various exposure doses according to a specific scheme.

Carbon structures were grown at a reduced pressure in a flow-type quartz reactor by pyrolysis of ethanol vapor. On the sites exposed by different doses, the growth rate of the carbon material was different. As a result, we obtained 3D carbon structures. The structures obtained were investigated using Raman spectroscopy and atomic force microscopy. This work was supported by Russian Foundation for Basic Research (project no. 17-72-20044).

Preparation and characterization of tea polyphenol loaded porous core-shell nanofibers

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This study focused on the fabrication, characterization and release properties of tea polyphenol (TP) loaded electrospun porous core-shell structured nanofibers. During the coaxial electrospinning process, proper polymer systems were employed and parameters were adjusted. Therefore, ideal porous core-shell structured nanofibers were produced and the release behaviour of TP could be effectively controlled.

The morphology, structure and properties, of TP loaded electrospun porous core-shell structured nanofibers were investigated by a combination of fourier transformation infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD) and et al. The results showed ideal porous core-shell structured nanofibers were successfully prepared.

Finally, the cumulative drug release rate of TP loaded porous core-shell nanofibers were determined by ultraviolet spectrophotometer, and the antibacterial effects of these nanofiber membranes were investigated. The results showed the porous structure of core-shell nanofibers could enhance the release properties of TP and the antibacterial effects.


Lattice Distortion Model: Events’ Scaling on a Horizon of Space-time

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As the standpoint of this study is a creation of method based on the multi-scale modelling that was chosen as a way to collect and, in the case of high probability comparable with the experimental results or methods, to share all possible natural phenomena as some evidence of physical reality in crystalline materials. It also directs to the physical ascription of events related to the time and distance, velocity and temperatures that may change all together [1, 2]. The content of present study tries to be more consequent, paying parallel attention to adjacent disciplines and methods. Generally, the mechanical and thermodynamic states are crammed in so called non-holonomic mechanical system as a possible cause of some transformations of energies at atomic scale, and assuming this, we always are moved away from the bifurcation point that requires an assimilation of kinetic and potential energies. In the energies’ exchange analysis, the entropy is the result of some kind of reversibility (related to kinetic energy) and irreversibility (related to potential energy) processes. The energies’ peculiarities may naturally be as a source of in-/extrinsic exchange of temperatures in a process of heat transfer.
One of the main theses presented in this research is that the scaling of time and distance does not explain space behaviour up to/beyond a point of bifurcation and some applied computational procedures firstly demand more sophisticated insights and verifications among the theories that successfully are being used nowadays.


NANO-87

A Study on Antimicrobial Activities of Ni-coated CNT-reinforced Nano Composites

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In the last few decades, there has been increased interest in antibacterial materials because of varieties of environmental pollution [1]. Especially, antimicrobial polymer composites are interesting and promising applications. They can effectively control the microbial contamination by inhibiting the growth of microorganisms (bacteria, yeasts, moulds), which normally comes into direct contact [2]. This study was conducted to develop novel antimicrobial nano-composites, with the functionalized carbon nanotube (CNT). CNT was prepared by a pellet type using water and ethanol as a binder for filling amount (or filler content) in the composites and work convenience. In order to impart antimicrobial properties, nickel (Ni) coating was carried out by a well-known chemical reduction method. FE-SEM, EDS and XPS were used to characterize the Ni layer on the Ni-CNT. The mechanical strength of nanocomposites according to the amount of CNT filling was studied by tensile strength and fracture toughness tests. Staphylococcus aureus (S. aureus) and Escherichia coil (E. coil) were employed as the target bacterium on antimicrobial activities. From the results, it was found that the mechanical properties of nano-composite was enhanced with increasing metal and CNT content. Also, the Ni coating was confirmed to play an important role in the bactericidal action of antimicrobial nano-composites.

**NANO-88**

**Effects of Nanostructured Ni-coating on the Thermal Conductivity of Ni-CFs/Graphite Flakes/polypropylene Nano-composites**

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Commonly used polymers are electrical insulators with a low thermal conductivity [1]. By the addition of fillers to polymer the thermal behaviors of the polymers can be increased significantly. Thermally conductive polymer composites have been prepared traditionally by adding thermally conductive fillers, eg, graphite, carbon fibers, carbon blacks, ceramics or metallic particles. Carbon-based fillers appear to be the best promising fillers, coupling high thermal conductivity and lightweight. There is a strong interest to improve thermal conductivity of polymer composites by using carbon fibers (CFs). Also, in order to improve the thermal conductivity, the carbon fiber surface can be modified, such as metal plating, direct grown CNT and thermally conductive material coating. In this work, hybrid fillers, such as carbon fibers (CF) and graphite flakes (GF), were employed to prepare polypropylene(PP) based thermal conductive polymer nano-composites. In order to increase good thermal conductivity of the nano-composites, nano-size nickel particles were coated on carbon fibers by a chemical reduction technique as a function of metal content. The nano-size nickel-coated carbon fibers with various metal content were prepared in 1.0 inch size, and reinforced with 20 phr in all nano-composite samples by a compression molding technique. The content of graphite flakes were fixed at 20 phr as a thermal conductive additive. From the results, we observed that the thermal conductivity of the nano-size nickel-coated CF/GF/PP were enhanced with metal content on the fiber surface. This result indicates that metal coating on the fibers can act like a heat gate between GF and CF resulting in a decrease in the thermal loss of the nano-composites.


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**NANO-89**

**ELECTROCHEMICAL PERFORMANCE OF METALLURGICAL GRADE SILICON DECORATED GRAPHENE ANODES**

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Silicon (Si) is a very attractive candidate anode material for secondary lithium ion batteries because of alloying with lithium. Thus, it exhibits the highest theoretical energy storage capacity of 4200 mAh/g which is
approximately 10 times higher than graphite anode material (372 mAh/g) [1,2]. On the other hand, the poor cycling stability of the silicon based anode materials because of the severe volume expansion during the intercalation/deintercalation process inhibits its application. There are different methods to overcome the volume expansion problem. Using different nanostructures of Si materials such as nanowires [3], nanotubes [4], nanofibers [5] and porous materials [6], thus getting enough vacancies for the volume change during the lithiation and de-lithiation process is one of methods. On the other hand, using of silicon-carbon hybrid structures such as CNT or graphene are integrated into the Si material as anode is the second method [7]. Because of metallurgical grade silicon is cheap and readily available, using of this type silicon can be a solution for the development of li-ion batteries.

In this work, we reported the synthesis of Silicon/Graphene/MWCNT composite structures which were produced via high energy ball milling and slurry technique. Firstly, the large metallurgical grade silicon particles were converted micrometer silicon particles via high energy ball milling method. Then the samples were coated with carbon and etched by using hydrofluoric acid. Graphene oxide was produced by Hummer [8] method and reduced to graphene with hydrazine hydrate solution. Silicon/Graphene/MWCNT electrodes were produced via slurry technique.

Electrodes were prepared with different ratios of silicon. The structure and morphology of the composite electrodes were characterized by X-ray diffraction, Raman spectroscopy, scanning electron microscopy. The electrochemical characterization tests including galvanostatic charge/discharge, cyclic voltammetry and electrochemical impedance spectroscopy (EIS) measurement of the electrodes were carried out by using a CR2032 test cell. These high-performance graphene supported composite electrodes provide competitive properties relative to other electrode materials for Li-ion batteries.

Physical properties of titanium oxide thin films prepared by sol–gel spin coating

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TiO2 is one of the most extensively studied transition metal oxide because it possesses excellent properties such as chemical stability, non-toxicity, transparency, high refractive index, and high dielectric constant \[1–3\]. Therefore, TiO2 thin film can be a promising material and has a variety of applications for electro-chromic displays, dye-sensitized solar cells, gas sensors, antireflection films, planar wave guides, and optical filters. For environmental concerns, TiO2 is extensively used for photodegradation of organic and inorganic pollutants, photovoltaic energy production, and hydrogen production by water photosplitting. TiO2 thin films have been prepared by several techniques, including chemical vapor deposition (CVD), electron beam evaporation, sputtering, pulsed laser deposition (PLD), spray pyrolysis, and sol–gel process.

In general, sol–gel methods are more flexible and offer many advantages, such as low-cost processing, simplicity, easy coating of large surfaces, excellent film homogeneity, low-temperature processing, and the ability to produce fine films. In addition, sol–gel process does not require any high vacuum equipment. In this study, titanium oxide thin films were prepared by sol–gel method using spin–coating technique. The influence of aged sol and annealing temperature on the physical properties of titanium oxide thin films were investigated.


Wettability and optical properties of SnO–SnO2–Sb2O3 thin films deposited by simultaneous RF and DC magnetron sputtering

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Transparent conductive oxides (TCOs) of indium oxide, tin oxide and zinc oxide are widely used in many optoelectronic applications of heat mirror, solar cells, transparent electrode, liquid crystal displays (LCDs), flat panel displays (FPDs), and light emitting diodes (LEDs) because of their high optical transmittance in the visible light region and high electric conductivity \[1, 2\]. This has stimulated research for finding new and lowcost TCO materials containing more abundant elements. In recent years, SnO2-based TCOs have attracted considerable attention in experimental and theoretical studies owing to its high chemical stability as well as excellent electrical and optical properties.
Thin films based on tin oxide with an additional oxide incorporated instead of expensive catalytic metal could be investigated. In addition, tin oxide exists in two forms—stannous oxide/tin monoxide (SnO) and stannic oxide/tin dioxide (SnO2). The conversion of SnO into SnO2, during the heating process, and presence of mixed phases (SnO + SnO2) may affect the performance of thin film. SnO–SnO2–Sb2O3 thin films were prepared by simultaneous RF and DC magnetron sputtering in this work. To ensure that the coexistence of SnO and SnO2 in the deposited films, the substrate temperature is kept as high as possible. The object of this study is to investigate the way in which the ratio of O2/Ar pressure affects the structure, wettability and optical properties of SnO–SnO2–Sb2O3 thin films.


**NANO-93**

**Synthesis of hybrid nanoparticles composed of doxorubicin/PLGA/chitosan/graphene oxide**

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It is well known that the biocompatibility of poly(lactic-co-glycolic acid) (PLGA) is high, thanks to which PLGA-based nanoparticles (NPs) have been intensively studied for biomedical application [1]. It is also known that graphene oxide (GO) possesses high biocompatibility, low toxicity and high thermal conductivity. Therefore, GO has been paid a lot of attention as a vehicle for drug delivery and a medium for photothermal therapy. In the present study, doxorubicin (DOX)-loaded PLGA NPs (Fig. 1a), which are immobilised with chitosan and GO, (DOX-PLGA-GO NPs) (Fig. 1b) are synthesised and the structures are fully characterised by SEM, TEM, FTIR and XPS. The surface charge and size distribution of the NPs dispersed in water are also measured by Zetasizer.


**NANO-94**

**Patterns formed by magnetic particles in combined dc and ac magnetic fields**

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Patterns formed by magnetic particles in external magnetic fields have been paid a lot of attention to in recent years aiming at the utilisation of the patterns for the construction of nano/micro structures on the surface of...
substrates and devices [1]. Here, we study the patterns formed by paramagnetic microparticles subjected to ac and dc combined magnetic fields which are applied synchronously in orthogonal directions to each other [2]. The structure of the resulting assembled microparticles is observed with a digital microscope. It is found that the cluster structures change depending on the control parameters such as the frequency of the ac magnetic field and volumes fraction (see Figure 1). The dependence of the dynamics and structures of the clusters; e.g., the growth, fractal dimension and pair-correlation function of the clusters, on the control parameters is fully analysed and clarified.


NANO-95

Synthesis of magnetic nano crystals via pyrolysis in ethanol

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Magnetic nanoparticles have been paid a lot of attention to in recent years aiming particularly at the utilisation of them in the field of biomedicine; e.g., hyperthermic treatment of cells, magnetic separation of cells and drug delivery to target cells. Magnetic particles have been synthesised by photolysis irradiating a laser beam into super-critical CO₂ [1]. It is also well known that the size and shape of crystals can be controlled by changing the pyrolytic temperature [2]. In the present study, we propose a method of synthesising magnetic nanoparticles via pyrolysis in ethanol, in which ferrocene is dissolved. 23.6 mg of ferrocene and 3.95 g of ethanol are confined in a 30 mL container made of stainless steel. The temperature and pressure of the solution are, respectively, set at (250 °C, 2.86 MPa), (300, 3.14), (350, 3.41) and (400, 3.69) for 1 h and then the solution is cooled naturally down to room temperature. The material produced is separated by centrifugation and dried in a desiccator for 24 h. The structures of the material are observed by a scanning electron microscope (SEM) (see Fig. 1). The magnetic properties and the structures of the material are also measured by a super quantum interference device (SQUID) and X-ray diffractometry (XRD). The dependence of the size, shape and quantity of the nanoparticles on the synthetic temperature is clarified.

NANO-98

Formation of concentric patterns composed of fullerene nano-fibres via convective self-assembly

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Nanoscale patterns can be formed via both top-down ultra-fine processing and bottom-up self-assembly technology. Periodic patterns formed via bottom-up self-organisation has been actively investigated in recent years [1]. Various patterns can be formed by nano/micro particles directly on the surface of substrates and devices utilising so-called the coffee ring effect, which is expected to be applied to the development of bio sensors and photonics materials [2]. It is known that spiral patterns of fullerene molecules can be quite easily deposited on the glass substrate utilising the coffee ring effect [3]. In the present study, we successfully synthesise concentric patterns of arbitrary shapes composed of fullerene nano-fibres, evaporating a droplet of fullerene-sulphur solution in cavities of different shapes such as a circle, triangle, quadrangle and rhombus, which are placed on a glass substrate. The dependence of the concentration of the solution and the initial temperature of the substrate on the patterns is clarified.


NANO-99

Combustion Synthesis of Silicon Dioxide Nanoparticles using Premixed Burner with Central Precursor Port

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Silicon dioxide (SiO₂) nanoparticles are used as additives in plastics and rubbers to improve mechanical properties of elastomers and in liquid systems to improve the suspension behavior [1]. Combustion synthesis is an effective technique to produce a wide variety of advanced materials that include nanoparticles and net shape products of ceramics, intermetallics, composites and functionally graded nano size materials [2]. The objective of this research was to investigate the combustion synthesis of silicon dioxide nanoparticles using the premixed burner effective to mass production of nanoparticles. The premixed burner consists of sintering plate to form stable premixed combustion flame. The bronze sintering plate was 5cm×5cm cross section and a thickness of 0.6cm and consisted of central precursor port on the sintering plate. The results show the blue flame is found to be very stable at heating loads 1.5 kW by implementing the proper sintering plate. The blue flame has a wide stability region and showed the lowest CO and NOx emission at equivalence ratio. CO emission was measured 3ppm (0% oxygen base) from 0.708 to 0.804 of equivalence ratio and NOx emission is 67ppm (0% oxygen base) under the same equivalence ratio. The synthesis flame patterns were taken by decreasing the premixed burner equivalent ratio at a fixed heating load. As the synthesis flame
patterns was changed from red radiation flame to weak blue flame with decreasing the premixed burner equivalent ratio at the constant silane concentration.


NANO-103

Activity of an enzyme immobilized on ferromagnetic particles under an ac/dc combined magnetic field

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Ferromagnetic particles subjected to a radio frequency alternating magnetic field dissipate heat caused by magnetic hysteresis and eddy currents. We have demonstrated that an enzyme immobilized on ferromagnetic particles is activated under an ac magnetic field thanks to heat generation from the particles [1,2]. In this study, we show that the enzymatic activity is further increased under an ac/dc combined magnetic field. We immobilize α-amylace on iron particles and analyze its activity under an external magnetic field. Fig. 1 shows the SEM image of the α-amylace/iron particle hybrids. We find that the activity of α-amylace on the particles is raised by an ac/dc combined magnetic field compared to that under an ac magnetic field and the activity increase changes depending on the angle between the ac and dc magnetic fields. We make clear the dependence of the enzymatic activity on the experimental parameters such as the amplitude of the ac magnetic field and the angle between the ac and dc magnetic fields.


NANO-105

Enhancements of hydrogen adsorption in M-MOF-525 (M=Zr, Ti and V): A first-principle study

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Electric and hydrogen adsorption properties of three different Metal-Organic Framework-525 (MOF-525), namely M-MOF-525 (M=Zr, Ti and V) were computed via the state of the art first-principle technique. Our calculation results revealed that the bond lengths between M-O (M=Zr, Ti and V) of the metal-oxide cluster unit increases as a function of atomic radius of metal in metal-oxide cluster. The increasing of the M-O distance results in enhancement of electric dipole moment of M-MOF-525. To investigate the hydrogen adsorption property, the hydrogen physisorption energy at various adsorption sites in the M-MOF-525 was determined. For
each adsorption site, two orientations of H-H bonding, namely parallel and perpendicular were considered. Based on our calculations, it was found that M-MOF-525 (M=Zr, Ti and V) are magnetic materials. This is because the energy obtained from spin polarized calculations is lower than that from spin unpolarized calculation. Moreover, the averaged M-O distances are 2.24, 2.05, and 2.10 Å for Zr-, V- and Ti-MOF-525, respectively. Moreover, five stable adsorption sites for placing hydrogen molecule on the M-MOF-525 surface was found. Our results also revealed that the Ti- and V-MOF-525 are unable to bind hydrogen molecule on its surface. For Zr-MOF-525 [1], the hydrogen can trap on this structure with hydrogen adsorption energy ranging from 0.04-0.15 eV/H₂. Finally, we believed that the Zr-MOF-525 can be used as low temperature hydrogen storage material.


NANO-106

Synthesis and Physical Properties of Delafossite CuBO₂ p-type Transparent Conducting Oxide

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CuBO₂ delafossite oxide was synthesized using a molten salt method. The microstructural, optical, magnetic, and electrical properties were investigated. X-ray diffraction (XRD) analysis results revealed the delafossite structure with a hexagonal $R\bar{3}m$ space group. The optical properties measured at room temperature using a UV-visible spectroscopy showed a weak absorption in the visible light and near IR region. The corresponding direct optical band gap was 3.6 eV, exhibiting transparency in the visible region. Thermogravimetric analysis indicated a weight loss of 8%, which was attributed to excess oxygen. The magnetic hysteresis curve measurements showed the CuBO₂ samples exhibit ferromagnetic behavior at room temperature. The positive Seebeck coefficient confirmed p-type behavior. The electric conductivity at room temperature was thermally activated with an activated energy of 62 meV. CuBO₂ delafossite is p-type transparent conducting oxide with a wide band gap, which may have potential in p-type electrode industry.

NANO-107

ZnO Nanorod Arrays Grown on Locally Modified Substrates

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A great deal of interest has been recently directed towards the design of new devices using one-dimensional semiconductor nanostructures. Despite a large number of applications, the anisotropic growth of ZnO from
solutions is not well understood and the growth technology mostly relies on empirical results. We investigated the growth mechanisms of hydrothermally prepared ZnO vertical nanorod arrays on patterned substrates and seed layers in conventional batch reactors as well as continuous-flow reactors to precisely control the solution supersaturation [1].

ZnO is a direct wide bandgap semiconductor crystallizing in the wurtzite structure with a series of unique properties: a large exciton binding energy; good optical transmittance in the visible region; high optical gain; piezoelectricity; room temperature ferromagnetism; mechanical stability given by the high melting point and large cohesive energy; radiation hardness; or biological compatibility. These properties allow for applications of ZnO in UV light-emitting devices and detectors, field-effect transistors, solar cells, piezoelectric nanogenerators, or chemical sensors. For the majority of these applications, upright standing arrays with controlled positioning, sizes, and physical properties are appreciated.

The upright standing arrays of ZnO nanorods were prepared by hydrothermal growth on Si substrates with textured and randomly oriented ZnO seed layers and on GaN epitaxial layers patterned by electron and ion beam lithography. To study the electric charge transport in the nanorods, electrical contacts were formed by the deposition of colloidal graphite [2], by metal evaporation and by the deposition of Pt using the gas injection system in the SEM. The transport properties were correlated with the structural and optical properties investigated by x-ray diffraction and photoluminescence spectroscopy.


NANO-108

Mechanisms of Electrophoretic Deposition of Metal Nanoparticle Monolayers

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We report on the formation of Pt nanoparticle monolayers by electrophoretic deposition from nonpolar solvents on Si substrates. First, the growth kinetics of Pt nanoparticles prepared by the reverse micelle technique is described in detail. Second, a model of nanoparticle charging in nonpolar media is discussed and methods to control the nanoparticle charging are proposed. Finally, essential parameters of the electrophoretic deposition process to control the deposition of nanoparticle monolayers are discussed and mechanisms of their formation are analyzed. In contrast with more conventional polar solvents, the use of nonpolar solvents: (a) limits the current between the electrodes; (b) reduces the changes in the composition and conductivity of the medium due to the generation of charged species near the electrodes; and (c) suppresses electrochemical reactions at the electrodes. To understand basic mechanisms of EPD in nonpolar solvents, it is essential to identify the origin of electric charge on individual nanoparticles. We developed a theoretical model which assumes that in a nonpolar colloidal suspension a small fraction of reverse micelles carries electric charge [2]. These charged micelles are adsorbed on the nanoparticles and thus are a source of their charge. Qualitative results of the model describe how the charge on the nanoparticles varies as the reverse micelles are removed by centrifugation and how the nanoparticles deposit onto a substrate.
Fabrication and characterization of porous and highly aligned PAN/graphene nanocomposites

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Traditional electrospinning method (ES) is an efficient method to prepare nanocomposites. However, the nanocomposites obtained by ES are usually random with low mechanical and electrical properties [1]. It is encouraging that these properties can be improved by fabricating highly aligned composite nanofibers. In this paper, porous and highly aligned PAN/graphene composite nanofibers were prepared at a moisture of 45±5% by a modified parallel electrode method (MPEM) via electrospinning, see figure 1 [2,3]. And a positively charged copper ring was placed between the needle and the parallel electrode collector. The solution system was made up of PAN/graphene, N-dimethylformamide (DMF)/water. The concentration of PAN varied from 8 to 12 wt% with the water content changing from 2 to 8 wt%. When the concentration of water was 5 wt%, the obtained composite nanofibers were made of many ultrafine and spherical fibers; when the water content was 8 wt%, the solution system couldn’t be spun; And when the concentration of water was below 5%, the porous and aligned nanocomposites were prepared. In addition, the viscosity and conductivity of the solution were enhanced with the increasing mass ratio of PAN and graphene. The structure and properties of PAN/graphene nanocomposites were characterized by Fourier transform infrared (FT-IR), transmission electron microscopy (TEM), X-ray diffraction (XRD), and thermogravimetry (TG). The results indicated that graphene was introduced into PAN nanofibers successfully. The morphology image of the nanofibers was detected by scanning electron microscope (SEM) and showed that many pores aligned the nanofibers.


Large-area and cost-effective fabrication of Ag-coated polymeric nanopillar array for surface-enhanced Raman spectroscopy

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Surface enhanced Raman spectroscopy (SERS) is a powerful spectroscopy technique for detecting trace amounts of chemicals and identifying them based on their unique vibrational characteristics. The decisive factor
in the commercialization of the substrates used for this SERS analysis is throughput and cost. Here, we demonstrate a facile, large-area and cost-effective method to fabricate variously shaped Ag-coated polymeric nanopillar array. The combination of multi-step anodizing and replication technique successfully modified the shape of nanopillar to unique morphologies of cylinder, beer-bottle, and cone with the diameter of 80 nm and the height of 180 nm. When Ag nanoparticle was uniformly deposited on the surface of nanopillar arrays, the thermal aging of Ag-coated nanopillar array strongly affected the SERS performance of which the maximal enhancement was achieved around 50 °C. While the highest enhancement factor was obtained from the beer-bottle shaped nanopillar, the cylindrical nanopillar showed the best reproducibility. The SERS signal intensity obtained from Ag-coated nanopillar array substrate was linearly proportional to the concentration of analyte, indicating Ag-coated nanopillar array is very suitable for quantitative chemical sensor.


NANO-111

Aqueous Rechargeable Na-ion battery based on Polypyrrole-CNT nanowire as anode and Na$_{0.44}$MnO$_2$ nanorod as cathode


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Rechargeable lithium-ion batteries (LIBs) are rapidly extended from portable device to electric vehicle and smart grids. While its quite mature, there remain questions regarding safety, lifetime, and cost. With this background, sodium-based batteries are recently received interest as a low cost alternative to lithium-ion batteries due to the high availability of sodium sources, and the similar chemistry of sodium and lithium. In this study, we focused on Polypyrrole-CNT as an anode material for aqueous sodium-ion battery, and high performances of Polypyrrole-CNT // Na$_{0.44}$MnO$_2$ full cell system. For anode active material, polypyrrole (PPy) was conformally coated on the surface of multi-walled carbon nanotube (CNT). PPy was very stable during the sulfate-ion doping and undoping processes in the aqueous solution without evolution of hydrogen. And, the search for a suitable cathode material, we concentrated our attention on the Na$_{0.44}$MnO$_2$ nanorod because of its rate capability. In our system, both of cation (Na$^+$) and anion (SO$_4^{2-}$) participate in the charge and discharge process. When charged, anode and cathode simultaneously release sulfate-ion and sodium-ion, and contrariwise during discharged. Therefore, the ratio of SO$_4^{2-}$/Na$^+$ is always constant to keep the electrolyte neutral, although the each concentration of SO$_4^{2-}$ and Na$^+$ is changed. It is expected that all of these could improve the rate capability and cycling performance.

NANO-112

MWCNT-polyimide core-shell nanowire as high capacity anode and cathode material for aqueous rechargeable sodium-ion battery

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Recently, lithium-ion batteries (LIBs) have been actively studied for large-scale electric energy storage applications. However, their safety, superfine discharging performance and finite supply of lithium are still challenging issues. In order to circumvent this problem, we used an aqueous electrolyte for sodium-ion batteries (NIBs), which is manufacturing competitiveness, environmentally benign, infinite abundance and fast ionic conductivity.

In this study, we synthesized MWCNT-polyimide core-shell nanowire based on pyromellitic dianhydride (PMDA) and 4,4'-oxydianiline (ODA) as high capacity anode material for aqueous rechargeable sodium-ion battery. It delivered excellent initial discharge capacity as high as 234.9 mA h g\(^{-1}\). However, during charging/discharging, the nanowire was rather thinned in contradiction to the swelling of electrode, and squashed flat surface were formed under the nanowires. It seems that the separation of polyimide from MWCNT and disruption of core-shell structure should lead to the irreversible swelling of electrode film. As a result, there was large decay of performance from 234.9 to 74.6 mA h g\(^{-1}\) over 100 cycles. In order to inhibit the swelling and consequently improve the cycle performance, polypyrrole was coated on the surface of MWCNT-polyimide core-shell nanowire. After 100 charge-discharge cycles, polypyrrole-coated core-shell nanowire retained a specific capacity of 209.3 mA h g\(^{-1}\), corresponding to 77.8% of the initial capacity, without any swelling. The effect of polypyrrole coating on kinetic property was investigated by electrochemical impedance spectroscopy (EIS) measurements. The EIS result revealed charge transfer resistance of polypyrrole coated electrode was much lower than that of bare electrode. This demonstrated that the polypyrrole layer successfully inhibited the swelling of polyimide and consequently improved the cycling performance.


NANO-114

The puncture behaviors of textile structure composites impregnated by Shear Thickening Fluid

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Textile structure composites are widely applied in various fields such as body armor, aerospace industry and military equipment. This paper reports the puncture behaviors of textile structure composites impregnated by Shear Thickening Fluid (STF) which is a dispersion system of nano silica/polyethylene glycol (SiO\(_2\)/PEG). The rheological property and microstructure of STF were tested to evaluate the influence of SiO\(_2\) particle size, additives, dispersion process on the puncture behaviors of final composites. The surface characteristics of
untreated and STF-treated fabrics were measured by scanning electron microscope (SEM) which helps to study the damage morphology and mechanism of fabric. The surface characteristics of silica nanoparticles and additives were also measured by transmission electron microscopy (TEM). The results demonstrate that the puncture behaviors of woven fabric is significantly enhanced due to the presence of STF.

NANO-115

Gold nanostars, graphene nanostructures for Surface Enhanced Infrared Absorption

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Nowadays, there is a huge research and technological interest in the utilization of noble metals nanstructures and their optical properties. Especially, noble metal nanoparticles and their assemblies are in the focus of extensive research activities. Taking advantage of the particle’s localized surface plasmon resonances, noble metal nanoparticles are used to alter light matter interaction on the nanoscale. In particular, nanoparticles such as gold nanostars exhibiting multiple plasmon resonances in the visible and NIR and strong plasmonic hotspots, highly localized and strongly enhanced electromagnetic fields, are apt to enhance surface absorption [1]. Recently, graphene turn out to be a promising material for optoelectronics and photonics thanks to its exceptional optical and electrical properties. In addition, electromagnetic fields of graphene IR plasmons show unprecedented spatial localization, making them extremely attractive to enhance interaction between light and matter and integrated IR photonics. Medium infrared range is especially suitable for biosensors, as it covers the molecular vibrations, allowing the unique identification of biochemical elements such as proteins, lipids and DNA. [2] Surface enhanced infrared absorption (SEIRA) spectroscopy is a very effective method to investigate small amounts of chemical and biological substances. Here, we show experimentally that graphene combined with gold nanostars can be used as efficient nanostructures for SEIRA. We compared the influence of two types of nanostars that differ by size and spectral position of their plasmon resonances on the IR spectra of thymine molecules adsorbed onto these nanoparticles. For the experiments, we synthesized two different sized nanostars, Au1 and Au2 type, with average sizes of 50 nm and 80 nm, respectively.

We find that the nanostars with plasmon resonances reaching in in the infrared range demonstrate higher enhancement factors in SEIRA experiments with thymine molecules adsorbed on the gold nanostars. Depending on the type of molecular group, the individual enhancement factors can higher compared to the enhancement factors of thymine molecules adsorbed on flat gold films. Moreover, composite nanostructures consisting of nanostars Au2 type and graphene can enhance IR absorption signals of thymine more than the nanostars without graphene. The individual amplification factors for N1-H group of thymine reaches 25 for the complex thymine/Au2/graphene , indicateting that thymine was adsorbed on the gold surface by this group.

Analysis of thin multi-layer structures by using Hall effect measurement

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In recent years, thin multi-layer structures are indispensable to multi quantum wells or super-lattices, which have been widely used in advanced electron devices in nano electronics, optoelectronics and spintronics. It is difficult, however, to characterize of electric properties of each layer separately. In this study, we propose an analysis method for estimation of carrier density of each layer in a two-layer structure, and verify it experimentally.

In a two-layer structure, we assume a parallel-resistance model, in which the relationship between carrier densities of the upper layer, the lower layer and the whole structure is formulated [1]. If we obtain carrier densities of one layer and the whole structure experimentally, we can estimate the carrier density of the other layer, even when it cannot be measured experimentally.

We verify our method by using a GaAs substrate with two layers. We measure carrier density of the lower layer after removal of the upper layer, and we estimate that of the upper layer using our approach. We demonstrate that the ratio of the carrier densities of two layers can be estimated approximately. The results will be reported in detail.

Our approach will be useful for characterization of advanced electron devices with thin multi-layer structures.


A New Scaling Parameter of FinFETs

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To suppress shoot channel effect (SCE), various types of MOSFETs including silicon-on-insulator (SOI) fully depleted MOSFETs [1], fully inverted MOSFETs [2], double gate FETs [3], and FinFETs [4] have been proposed. Subthreshold slope S has been widely used to discuss SCE quantitatively. We have investigated the behaviors of S in thin SOI MOSFETs, and have discussed what we should do to suppress SCE in SOI MOSFETs effectively [5–7]. In this study, we investigate S of FinFETs to suggest new guidelines of design for FinFETs. We perform device simulations of SOI FinFETs as shown in Fig.1, and from the simulated results, we extract subthreshold slope S. We propose a dimensionless factor α as a new scaling parameter, and we investigate the dependence of S on α. As a result, we demonstrate that S is determined almost only by α, even when W, H, and L are varied in the wide range. The definition of α and its physical interpretation will be explained in detail. Device simulations in this work are performed by using Sentaurus TCAD, which is supported by VLSI Design and Education Center (VDEC), The University of Tokyo with the collaboration with Synopsys Corporation.

NANO-118

Novel 3D Cu$_6$Sn$_5$@C/Graphene-MWCNT Nanocomposite Structures for High Capacity Electrode Materials for Li-Ion Batteries

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Rechargeable batteries, are used on a daily basis in a variety of consumer, industrial, and military applications. Although there are still too many challenges that should have to be overcome, the rechargeable batteries offer a cost effective, non-toxic and reusable source of energy for today’s world. Tin anodes have attracted much attention because it delivers a capacity up to three times higher than that of graphite. Theoretically, one tin atom can maximally react with 4.4 lithium atoms to form Li$_{4.4}$Sn alloy, reaching a capacity of 993 mAh g$^{-1}$. However, the large amount of lithium insertion/extraction into/from Sn causes a large volume change (about 300%), which causes pulverization of tin particles and loss of contact with current collector, resulting in poor electrochemical performance.

In this study, nanosized tin nanoparticles are synthesized by chemical reduction technique. The Cu$_6$Sn$_5$@C/Graphene-MWCNTs electrode material exhibits a stable reversible capacity of 521 mAh g$^{-1}$ after 100 cycles as the anode of lithium-ion batteries, indicating that the composites might have a promising future application in Li-ion batteries. The results have shown that Cu$_6$Sn$_5$@C/Graphene-MWCNTs nanocomposite displays superior Li-battery performance with large reversible capacity, excellent cyclic performance, and good rate capability, highlighting the importance of the anchoring of nanoparticles on graphene sheets with MWCNTs for maximum utilization of electrochemically active Cu$_6$Sn$_5$ nanoparticles and graphene-MWCNTs for energy storage applications in high-performance lithium-ion batteries.

**NANO-119**

**Freestanding Nano Crystalline Tin@Carbon Anode Electrodes for High Capacity Li-Ion Batteries**

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Due to the high energy density and long cycling life, lithium ion batteries (LIBs) have been utilized as promising power sources for mobile devices, electric vehicles, and energy storage systems. In face of the increasing demand for next generation lithium ion batteries, tin (Sn) has attracted much attention owing to its high theoretical capacity (991 mAh/g, lithiated to Li₄.₄Sn).

Herein is reported that we comparatively study the electrochemical characteristics of Sn, Sn@C and vacuum-assisted filtration fabrication of a novel free-standing Sn@C/Graphene nano composite. Sn@C nanoparticles were designed in the form of “core-shell” architecture. In this architecture, Sn nanoparticles were the “core” while an amorphous carbon layer as around the Sn nanoparticles was the “shell”. There are numerous advantages of core-shell structure such as providing a self-supporting framework while well-controlled void space between the Sn nanoparticles and the carbon shell allows for the Sn nanoparticles to expand upon lithiation without breaking the carbon. In addition to core-shell architecture, the intrinsic properties of graphene having large surface area, highly conductive network which can provide good contact between Sn–C nanoparticles, tolerating large volume change and suppressing aggregation of Sn@C nanoparticles during charge/discharge processes. The best of our knowledge, graphene oxide based free standing electrodes are not reported at all.


**NANO-120**

**Development of Bioplastic electrospun membranes based on tree gums**

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Tree gums are innovative biodegradable carbohydrate polymers for food, pharmaceuticals and other industrial applications. Very recently, electrospun fibres of tree gums such as Arabic, Karaya and Kondagogu gums have been prepared by electrospinning [1–4]. The present paper highlights the development of bioplastic membranes from gum electrospun fibres and their characterizations and applications (both environmental and food packaging). The process of electrospinning and various structural, mechanical and physicochemical properties of the bioplastic membranes were investigated. Furthermore, the comparisons of various functionalities of the untreated and treated bioplastic membranes such as specific surface area, crystallinity index, thermal stability, improved water contact angle, high surface porosity and roughness and superior hydrophobic properties utilizing both plasma and gamma ray irradiation techniques were assessed.
To increase the energy storage capacity of Na-ion batteries (SIBs), novel anode materials having excellent electrochemical properties need to be intensively studied. Tin is one of the most promising anode material for the next-generation SIBs. In a typical sodium insertion mechanism, one tin atom can react with 4.4 lithium atoms to form Na$_{4.4}$Sn alloy, reaching a theoretical capacity of $\sim 847$ mAh g$^{-1}$[1]. However, a large amount of volumetric expansion about 300% occurs during the sodium intercalation process, which causes aggregation, leading to considerable mechanical stress in particles. Recent studies have shown that conductive shell architectures such as core-shell structures could effectively buffer the mechanical stresses and hence significantly improve the electrochemical properties of anode or cathode active electrodes [2].

In this study, a “core-shell” structure for a stabilized and scalable tin anode is designed. Tin nanoparticles (\sim 30-130 nm) as the “yolk” were produced through a facile chemical reduction synthesis method. The surfaces of the tin nanoparticles were subjected to microwave hydrothermal carburization in order to obtain the shell structure. Graphene based freestanding electrodes were then obtained through a facile vacuum filtration technique. The electrochemical properties of the nano structured tin, tin/carbon and graphene reinforced tin/carbon freestanding electrodes were investigated in detail.

Electrochemical Performance Study of Graphene/MWCNT/Si-Yolk-Shell Freestanding Anodes for Lithium Ion Batteries

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Due to lack of satisfying high energy demands of electrical vehicles and portable electronic devices, commercial graphite anodes are trying to be replaced with anode materials which are able to provide higher energy density and better cycling properties. Numerous efforts have been made by researchers to develop high capacity silicon anodes for increasing energy density of lithium ion batteries. Silicon possess the highest theoretical capacity of 4200 mA h g⁻¹ which is ten times higher than that of commercial graphite anodes (372 mA h g⁻¹). Despite of highest theoretical capacity, rapid capacity loss and poor cycling capacity due to volumetric expansions and unstable solid electrolyte interphase (SEI) hinders silicon anodes to be commercialized. In our work cycling performance of silicon anodes were aimed to be enhanced by free-standing Graphene/MWCNT/Si-Yolk/Shell composite anodes. Nano-sized Silicon-Yolk/Shell particles were decorated into graphene/MWCNT skeleton structure via vacuum filtration to produce free-standing anodes. Scanning and transmission electron microscopy techniques were used for morphological characterization of anodes. X-Ray diffraction and RAMAN spectroscopy techniques were performed for phase analyses. Electrochemical characterizations of anodes were carried out via assembling CR2016 coin cells by techniques including of galvanostatic charge/discharge, cyclic voltammetry and electrochemical impedance spectroscopy. Acknowledgements: This work is supported by the Scientific and Technological Research Council of Turkey (TUBITAK) under the contract number 214M125-A New Approach in Graphene Synthesis and New Generation Graphene Based Li-Battery Electrodes.

Effect of the real interface roughness on the stress distribution and crack propagation in thermal barrier coating using finite element method

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Thermal barrier coatings (TBC) are corrosion-protecting multilayered systems deposited on the crucial turbojet engine components such as turbine blades. Considering application of TBCs they must withstand high centrifugal loads at elevated temperature in corrosion atmosphere. One of the main issue in designing new kinds of ceramics coatings is residual stress level generated during exploitation process. In present work finite element model of TBC fabricated in atmospheric plasma spray (APS) process was developed. Numerical model, composed of top coat - ZrO₂+20%Y₂O₃, thermally grown oxide (TGO) – Al₂O₃, bond coat (BC) β-NiAl and
substrate – Inconel 713C, was created as real interface shape between the layers based on scanning electron microscopy (SEM) characterization. In our model all the layers are treated as elastic and viscous capable of elastic deformation with temperature-dependent materials properties. Influence of the morphology – interface shape – on level and distribution of the residual stress was investigated through simulation of thermal cycle process. Furthermore, due to the fact that failure mechanism of TBC still remain unsatisfactory described analyse of crack propagation in ceramic layer was performed. Crack propagation paths were chosen in zones where relatively high $S_{22}$ stress components occurred during thermal cycle. The results of numerical simulations revealed that real interface with combination of TGO growing highly affect a temperature field and residual stress level. Moreover, creep relaxation decreases the stresses and energy release rates when crack propagation is taken into account.

NANO-125

Potassium gadolinium tungstate doped RE ions as potential nano-sized material for medical imaging

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Medical diagnostics is still not perfect enough for the early detection of cancer. Nowadays, dominating diagnostic methods using ionizing radiation is dangerous to human health. Nano-phosphors due to the small size of the particles can easily penetrate into the interior of the body tissues. Lanthanide ions are distinct types of luminescence centers. The lanthanum ions as a dopant in the phosphor to achieve the sufficiently high emission efficiency. These nanostructures had great potential to be used in medical diagnostics. Despite this fact, the information on such an application, has appeared in the literature since 5 years.

In order to use them area for medical diagnostics they have to fulfill few very important requirements as: sizes of particles in the nanometer scale (1-100nm), optical transparency for tissue (without absorption of light in the tissue), long emission lifetime, emission light length between 600 – 900 nm, excellent photostability, highly, efficient, low extent of agglomeration and low-short term toxicity with biocompatibility.

KGW monocrystals are played important role in electronics as very attractive materials for solid state lasers. In our research, we study assessment nanoparticles of potassium gadolinium tungstate doped with rare earth ions KGd(WO$_4$)$_2$ (KGW:RE) on the different human cells by in vitro tests. The aim of our research are study of cytotoxicity an active luminescence nanoparticles in KGW:RE chemical form in vitro model.
NANO-126

A Review on Electrodeposition of Ni-Based Nanocomposites: Effect of Alloying Elements and Reinforcements

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Ni matrix nano-composite coatings have become the focus of widespread research in recent years due in part to their superior properties when compared to purely metallic films. Electrodeposited Ni based alloys and nanocomposites have become an important component for new applications including: aerospace, automotive, electronics, biomedical implants, non-linear optics, mechanically reinforced lightweight materials, sensors, nano-wires, batteries, biocermics, energy conversion and especially in microelectromechanical systems (MEMS). Reducing the grain size of Ni electrodeposits to the nanocrystalline regime and using nano sized reinforcements (i.e. below 100 nm) has recently received considerable interest for MEMS applications. Nanocrystalline electrodeposits have substantially increased strength, hardness, and wear resistance compared to conventional polycrystalline electrodeposits. During the electrochemical coating processes, insoluble materials are suspended in a conventional plating electrolyte and captured in the growing metal film. The second phase material can be hard oxides (Al₂O₃, TiO₂, SiO₂) [1-2], carbides particles (SiC, WC), diamond, solid lubricants (PTFE, h-BN, graphite, MoS₂), and even microcapsules containing liquids [3]. In general, having second phase particles in a co-deposited film results in a variety of improvements in film properties, such as increased microhardness, yield strength, tensile strength, increased wear and corrosion resistance, self-lubrication and high temperature inertness [4,5].

This review presents a recent literature on electrochemically prepared nickel and nickel alloy nanocomposites coatings. These nanostructured coatings exhibit remarkable enhanced corrosion resistance and microhardness which are of interest for applications in diverse fields. This review presents the scientific framework for the advances in the nanocomposite coatings research, including fundamental composition/property relationships, fabricating techniques, and applications of nanocomposite coatings. Significant attention is paid to the deposition parameters mechanisms of metal-ceramic particles and carbonaceous materials (CNTs and graphene etc.) electrodeposition and different parameters affecting the electrodeposition process.

Carbon-Silicon Composite Anode Electrodes Modified with MWCNT for High Energy Battery Applications

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Due to the high energy density and long cycling life, lithium ion batteries (LIBs) have been utilized as promising power sources for mobile devices, electric vehicles, and energy storage systems. Anode materials plays an important role in determining the overall performance of LIBs. In face of the increasing demand for next generation lithium ion batteries, Si has attracted much attention owing to its ultra high theoretical capacity (4.200 mAh/g, lithiated to Li4.4Si).

In this study, we comparatively study the electrochemical characteristics of Si, Si-C and vacuum-assisted filtration fabrication of a novel free-standing Si-C/Multi Wall Carbon Nanotubes (MWCNT) nano composite. The MWCNT’s large surface area, highly conductive network which can provide good contact between Si–C nanoparticles, tolerating large volume change sand suppressing aggregation of Si-C nanoparticles during charge/discharge processes. Such a comparison between the performances of carbon-MWCNT-metal materials is reasonably envisaged not only to be useful for understanding the individual contribution from MWCNT and metal but also to form a fundamental basis for energy storage applications. Free-standing Si-C/MWCNT nano paper has been successfully obtained by a facile vacuum filtration method.


Non-enzymatic Electrochemical Lactate Biosensor based on Nickel Hydroxide

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Electrochemical biosensors have attracted great attentions for real-time analysis of metabolites such as lactate, glucose, and cholesterol, due to their high sensitivity and low limit of detection. [1] For lactate detection, biosensors embedded with lactate oxidase, enzyme active to lactate have been widely demonstrated [2]. Enzymatic biosensors, however, have some disadvantages in stability and reproducibility due to loss of enzyme activity over time by biofouling and biodegradation [3]. Therefore, there is a need for non-enzymatic lactate sensor offering long-term stability. Nonetheless, non-enzymatic lactate detection has been less explored, comparing to other metabolites.

Here, we propose a novel non-enzymatic lactate sensor based on transition metal oxide derivatives. We fabricated electrochemical active electrodes as depositing Nickel oxide (NiO) and Nickel hydroxide (Ni(OH)₂)
on glassy carbon electrode. Cyclic voltammetry (CV) analysis clearly exhibit amperometric response of NiO and Ni(OH)$_2$ based electrode on lactate at low voltage, 0.5V. The sensitivity of NiO and Ni(OH)$_2$ electrochemical sensor were measured as 0.98 $\mu$A/mMcm$^{-2}$ and 2.48 $\mu$A/mMcm$^{-2}$, respectively, that is similar level of other enzymatic lactate biosensor [4]. In addition, amperometric response of biosensor upon addition of lactate with different concentration display linear regime in the range of 0.1 to 25.6 mM which cover the lactate level of blood depending on the physical condition of person, 0.5 to 25 mM. Characteristics in microstructure and surface chemical state are also investigated with X-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS), thus reveal the origin of difference of NiO and Ni(OH)$_2$ electrode in amperometric response.


NANO-132

Biosynthesis of metallic nanoparticles using Aeromonas hydrophila as biotechnological tool

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Aeromonas hydrophila strain A is a $\gamma$-Proteobacterium facultative anaerobic chemo-organotroph capable of anaerobic respiration and dissimilatory metal reduction. We have already demonstrated that A. hydrophila is able to reduce and dissolve ferric minerals [1]. Very little is known about the mechanisms that confer the metabolic versatility that allows A. hydrophila to persist in polluted waters or its potential for biotechnology. Experimentally we have demonstrated that A. hydrophila is resistant to arsenite, arsenate, selenate, chromate, nickel and zinc. A. hydrophila possess transporters which may aid in the efflux of heavy metals or toxic compounds encountered in potentially highly polluted waters as well as some arsenate reductases [2]. We have observed that cells grown anaerobically with soluble Fe(III) as electron acceptor in presence of zinc, nickel and chromate produced extracellular nanoparticles of ZnS (10 nm), NiS (1 nm) and Cr(III)-hydroxide (3 nm). We have also observed that A. hydrophila is able to use selenate as sole electron acceptor producing nanospheres of 30-300 nm. When the strain was grown with arsenate as sole electron acceptor, arsenic nanoparticles with a diameter of 50 nm were formed whereas in presence of arsenite, nanowires and nanospheres with a diameter of 50 nm approximately and 900 nm nanospheres. In addition to their metabolic versatility A. hydrophila might be used in the production of metallic nanoparticles with photo-optical and semiconducting properties profitable for nanotechnology applications.

Effect of Surface Stress on the Interaction of a Dislocation with a Nanovoid

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The image force experienced by a dislocation is altered due to the presence of: (i) surface tractions, (ii) residual stresses and (iii) altered surface chemistry (e.g. an oxide layer or surface segregation). The effects of surface stress become prominent in nanostructures and can have profound effects on the configurational forces and torque experienced by the dislocation. Voids in materials act like sinks for dislocations in its proximity and image forces can provide the driving force to actualize the same. Detailed studies on the dislocation-void interactions have been reported earlier [1].

In the current work, we study the effect of surface stress (at the internal interfaces) on the interaction of an edge dislocation with a nanovoid in its proximity. Surface stress is computed using a two-scale method developed recently, which combines density functional theory with finite element method. Image force and torque experienced by the dislocation is computed using a finite element recipe, with and without surface stress, for climb and glide orientations. Aluminium is used as a model material and specific geometries are considered to elucidate the underlying mechanics involved.


H+ ions beam irradiation-induced interconnections between Ni-NWs for transparent conducting electrodes

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This study is based on fabrication of interconnections between Ni-NWs on small scale in various shapes such as II-, X-, V-, T-shapes etc by MeV H+ ions beam irradiation-induced nanoscale welding approach. Ni-NWs are exposed to 2.75 MeV H+ ions at beam fluence ~1x1016 ions/cm2 and temperature is kept at room temperature. Transmission electron microscopy (TEM), scanning electron microscopy (SEM) and x-ray diffraction (XRD) results show that perfect interconnections are fabricated between Ni-NWs with stable crystal structure. Subsequently, a two-dimensional large scale random mesh of Ni-NWs is fabricated by 3 MeV H+ ions beam irradiation-induced nanoscale welding of Ni-NWs at contact positions. 3 MeV H+ ion beam induced large scale
mesh fabrication of Ni-NWs is investigated by transmission electron microscopy (TEM) and scanning electron microscopy (SEM) and x-ray diffraction (XRD) techniques. Moreover, electrical and optical characterizations of these Ni-NWs are made using UV-VIS spectroscopy and four probe techniques. It is found that at a beam fluence of $\sim 10^{15}$ ions/cm$^2$, perfect II-, X-, and V-shape interconnects between Ni-NWs are achieved and finally lead to the fabrication of an optimum welded large scale Ni-NWs mesh with stable morphology and structure of NWs. These meshes are electrically conductive and optically transparent. Moreover, results show that Ni-NWs mesh is fabricated in three steps: (i) H$^+$ ions beam induced heat spikes leads to local heating of Ni-NWs, (ii) formation of interconnections between Ni-NWs on small scale, (iii) formation of interconnections between Ni-NWs on large scale. Large scale Ni-NWs meshes are suitable for application as transparent conducting electrodes in optoelectronic devices. H$^+$ ions beam irradiation-induced nanoscale welding of Ni-NWs could improve electrical performance of Ni-NWs mesh by reducing contact resistance between NWs. This observation is also important for application of optoelectronic devices based on Ni-NWs in extreme environment such as in upper space where H$^+$ ions are abundant in MeV to GeV energy range.

**NANO-135**

**Influence of Spark Plasma Texturing parameters on microstructure of aluminum composites reinforced with 2D crystals**

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Aluminum matrix composites offer favourable properties, such as high strength, improved hardness, and stiffness. Due to this fact, there are widely used in many branches of technology. Throughout the recent years a lot of attention has been devoted to composites with self-lubricating effect [1-2]. According to Woźniak et. al. [3], the required amount of solid lubricants needed to improve the tribological properties (the formation of a thin film on the surface) is about 10 vol.%. This in turn, causes the creation of agglomerations, which has a negative effect on mechanical properties.

The scope of this work includes preparation and characterization of AA6061-base composites reinforced with 10vol.% multi-layer graphene (MLG) and 10vol.% disulfide molybdenum (MoS$_2$) using a modified Spark Plasma Sintering method (SPS), called Spark Plasma Texturing (SPT) [4]. The influence of the degree of plastic deformation in the SPT process on density, microstructure, and mechanical properties was investigated. The results have been compared with composites obtained with the use of SPS method. The application of the SPT technique enabled to obtain composites with better dispersion of MLG and MoS$_2$ and better mechanical properties compared to those sintered by the SPS method.

**NANO-137**

**Design of durable Piezoelectric Nanogenerator Based on AlO-rGO/PVDF Nanocomposite with High Power Density for Biomechanical Energy Harvesting Applications**

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Till now development of durable, sensitive, and flexible piezoelectric nanogenerators (PNGs) with high power density and high energy conversion efficiency becomes a great challenge for next generation electronic applications. Here, we developed cost effective hybrid piezoelectric nanogenerators (HPNG) by integrating flexible steel woven fabric electrodes into poly(vinylidene fluoride) (PVDF)/ aluminum oxides decorated reduced graphene oxide (AlO-rGO) nanocomposite film, where AlO-rGO acted as nucleating agent for piezoelectric $\beta$-phase formation.

The HPNG exhibits reliable energy harvesting performance with high output and fast charging capability with superior durability. The HPNG exhibit an open circuit output voltage of $\approx 36$ V and short circuit current of $\approx 0.8$ $\mu$A, with instantaneous power density of $\approx 44.28$ W/m$^3$ under finger imparting. The HPNG is able to charge the capacitor in a very short time span ($\approx 6.1$ V in 96.6 sec), along with the ability of high energy conversion efficiency up to $\approx 12.47\%$ compared with pure PVDF nanocomposite. The HPNG can also instantly light up several colors LEDs and power up many portable electronics through an instantaneously charged capacitor. Importantly, HPNG retains its performance after long compression cycles ($\approx 158400$), demonstrating great promise as a piezoelectric energy harvester toward practical applications.


**NANO-138**

**Tribological properties of 6061 aluminum alloy matrix composites reinforced with MoS$_2$ nanoflakes and multi-layer graphene in vacuum environment**

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Molybdenum disulfide and graphite are the most common solid lubricants used in the form of coatings and as a reinforcement in self-lubricating composites in dry-friction. It has been shown that the morphology of the solid lubricant particles have a significant effect on the friction process [1] and, when used as a reinforcement will greatly affects the mechanical properties of composites. Based on previous research on consolidation in the Spark Plasma Sintering process (SPS) [2], self-lubricating materials based on AA6061 with 10 vol. % addition of multi-layer graphene (MLG) and molybdenium disulfide nanoflakes were prepared. Such minimal addition...
of solid lubricant was considered sufficient to produce stable trybofilm. Density, hardness and tribological testing under vacuum conditions were performed. Composites with MoS$_2$ addition have higher hardness and Young modulus compared to composites with MLG addition, and are twice as hard as the matrix material without additives. On the basis of the tribological studies, the higher suitability of MoS$_2$ was confirmed in the improvement of tribological properties in vacuum. For composites with molybdenum disulfide, a significant reduction in friction coefficient was observed. Unfortunately in the proposed friction process conditions, the composite materials were characterized by higher wear rate than the pure aluminum alloy sinters.


NANO-141

Nanostructure and magnetism of self-assembled Co$_x$C$_{60}$ hybrid films

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Combination of fullerene with transition metals promises new nanomaterials with attractive properties and intriguing application potential. Thus, combination of fullerene with cobalt under the Co$_x$C$_{60}$ hybrid film has revealed the remarkable candidate for application in spintronics and magnetic memory storage [1, 2]. The discovered potential of the hybrid films requires comprehensive knowledge about their nanostructure and magnetic properties that would elucidate applicability of the material. Here, we present the detailed analysis of the nanostructure and magnetic properties of the Co$_x$C$_{60}$ films (0 < $x$ < 50) fabricated by means of simultaneous deposition of Co and C$_{60}$ on Si(100). We demonstrate the clear dependence of the Co concentration $x$ on the film nanostructure, which designates $x$ as the main factor driving the structure self-assembling. The systematic approach to the film characterization allowed us to evaluate the specific intervals of $x$ that implies access to series of exclusive nanostructures. We found the remarkable correlations between nanostructure and magnetism of the Co$_x$C$_{60}$ films, which gave us a sight on possible origin of the Co fulleride and yielded the $x$ interval attractive for spintronics. Ex-situ conditions of some experiments yielded the effect of the air exposure, which remarkably illuminated the features of the film nanostructure as well as opened possible application of the Co$_x$C$_{60}$ films in sensors, catalysis and fuel technologies.

Preparation of nanoporous membranes using thermally induced phase separation method

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Global warming is deepening due to the increase of greenhouse gas by industrial development in the 21st century and water shortages are emerging together. More than 70% of the Earth’s surface is covered with water, but less than 1% of the water is known to be drinking, and research on water treatment technology to secure water resources is actively underway [1-2]. Polyvinylidene fluoride(PVDF) nanoporous membrane with excellent mechanical properties and chemical resistance was prepared and characterized for the application of water treatment. Dibutyl-phthalate (DBP) was used as a diluent for making a nanoporous membranes through temperature induced phase separation method, and the crystallization temperature, melting point, cloud point and SEM image were observed with different ratio of diluent in polymer/diluent mixture. The crystallization temperature and melting point increased proportionally with the content of polymer, while the cloud point temperature decreased. Finally, it was confirmed that stable membrane could be manufactured at a polymer content of 62wt% and a temperature 125°C using the phase diagram of PVDF/DBP mixtures with temperatures.


The composite membranes of poly(phenylene oxide) and polyethylene support containing quaternary ammonium for alkaline anion exchange membrane fuel cell applications

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Alkaline anion exchange membrane fuel cell (AEMFC) is attracting attention as an alternative energy source because of its high efficiency. Among the many components used in fuel cell systems, anion exchange membranes (AEM) are the most important component to transfer ions. AEMs require high ion exchange capacity, conductivity and mechanical strength for good performance of the system [1-3]. In this study, we synthesized poly(phenylene oxide) polymer containing various contents of quaternary ammonium to prevent the reduction in efficiency due to the introduction of supports. We prepared composite membranes using synthesized polymers and polyethylene(PE) supports. The composite membranes were characterized by different analytical techniques. For example, thermal and mechanical properties of composite membranes were analyzed by using TGA and UTM. The SEM images were used to confirm the formation of the composite membrane. The electrochemical properties which are important performance at anion exchange membrane were measured by titration method and membrane resistance method.
Chemically-deposited nanostructured CdS:Al/PbS thin films for photovoltaic applications

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Lead Sulfide (PbS) is a promising material for photovoltaic applications, as an absorber layer in thin film solar cells. It has a direct and narrow energy band gap of 0.41 eV at 300 K and presents a large exciton Bohr radius (18 nm), which provides strong quantum confinement of electron-hole pairs. This last feature permits us to control the value of the band gap by modifying the crystallite size. On the other hand, Cadmium Sulfide (CdS) is the commonly used optical window material in thin film solar cells due to its high optical transparency, wide band gap (2.42 eV) and n-type conductivity. Currently, chemical bath deposition (CBD) is a simple, inexpensive and scalable method to prepare CdS and PbS thin films, grown by precipitation in a controlled chemical reaction [1].

The aim of this work is to prepare a thin film solar cell based on the heterojunction CdS:Al/PbS, that were grown by CBD in an ammonia-free system. Here, CdS:Al corresponds to in situ Al-doped CdS thin films [2]. Their structural, optical, morphological, chemical and electrical properties were studied by XRD, UV-NIR spectroscopy, AFM, SEM/EDX and four point probes, respectively. The solar-energy conversion efficiency of the structure glass/FTO/CdS:Al/PbS/Ag was determined for different Al-doping levels and deposition times.


Schottky contacts on chemically-deposited nanostructured Al-doped CdS thin films

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Cadmium Sulphide (CdS) has been studied extensively for various applications such as solar cells and opto-electronic devices. Currently, chemical bath deposition (CBD) is a simple, inexpensive and scalable method to prepare CdS thin films, grown by precipitation in a controlled chemical reaction [1]. Also, it is well known that metal/semiconductor contacts are the most widely used rectifying contacts in the electronics industry and have found different applications such as infrared detectors [2].
In this work, nanostructured Al-doped CdS thin films were deposited in glass by CBD in an ammonia-free system followed by post-deposition thermal annealing at 200°C in air (~0.1 atm) for 3 h. Doping concentration was controlled in situ by varying the Al content in solution. In order to study the effect of Al-doping on the electron transport properties across a CdS/Metal junction, Au and Ag thin films were deposited on the annealed films by sputtering technique. Their structural, optical, morphological and electrical properties were studied by XRD, UV-NIR spectroscopy, AFM and d.c. current/voltage measurements, respectively. We found that for different Al-doping levels in CdS thin films, a transition from ohmic to Schottky contacts is observed across the junctions. Also, the threshold voltage of the thin film Schottky diodes was controlled by the Al content.


NANO-147

Calculation of electronic and thermoelectric properties of SrTiO$_3$

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In this work, 3 models of SrTiO$_3$, including pure SrTiO$_3$, N-doped and O-vacancy SrTiO$_3$ models, were investigated to study electronic and thermoelectric properties. Vienna Ab initio simulation package (VASP) which based on density functional theory was used to calculate electronic structure of SrTiO$_3$ with addition of Hubbard parameter (U) to treat the strong on-site Coulomb interaction in d-electron and thermoelectric properties were also investigated with BoltzTrap program. The results indicate that pure SrTiO$_3$ has energy band gap of 3.11 eV for GGA+U (U=8.7 eV) calculation which is underestimated compared with experimental value due to limitation of DFT. For N-doped model, there are states induced above valence band resulting in band gap narrowing about 0.38 eV. Removing of Oxygen atom make SrTiO$_3$ structure defect which lead to formation of a band below the conduction band. Thermoelectric results show that doping SrTiO$_3$ with Nitrogen and Oxygen vacancy can improve thermoelectrical of SrTiO$_3$ because of larger ZT when the temperature is increasing.
Investigation of Inkjet Printing Electrodes for Photocatalytic Water Splitting


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In this work, chemically modified TiO$_2$ electrodes for photocatalytic water splitting were fabricated by inkjet printing technique on FTO glass and titanium plate substrates [1]. As shown from cross-sectional scanning electron microscope, the thickness of the catalyst layer was around 700 nm [2]. The sintering temperatures of 300 and 450°C were studied under air atmosphere, subsequently the photoelectrochemical (PEC) activities of these electrodes were examined aiming at oxygen evolution reaction. The electrodes were characterized in PEC cells containing 0.5 M H$_2$SO$_4$ as electrolyte and a platinum ring as counter electrode. Under simulated sunlight, photocurrent densities up to 0.22 mA cm$^{-2}$ at 1.2 V(SHE) were obtained. The temperature of sintering significantly influenced the photocurrent of electrodes printed on titanium substrates, due to the formation of a thin titanium oxide interfacial layer at higher temperatures. However, in case of FTO, glass transition temperature of the substrate allowed 300 °C to be the optimum sintering temperature. Moreover, the stability of the electrodes were determined. It was found that the electrodes showed constant photocurrent under illumination at 0.7 V(SHE) for up to 5 hours.


AFM nanomechanical properties of hybrid coatings based on silica, zirconia and fluorinated polymers for high durability and scratch resistance on plastic substrates


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Newly prepared hybrid coatings with high scratch resistance and enhanced outdoor durability were successfully obtained via sol–gel pathways [1]. These materials, based on silica and zirconia crosslinked with a silanized fluorinated polymer, were applied on polymeric substrates by spin-coating. The effect of zirconia-to-silica molar ratio on the physical, chemical and mechanical properties of the hybrid coating was investigated. AFM nanoindentation and nanoscratch tests were performed to assess mechanical performance of the hybrid systems, resulting in a high modulus (up to 31 GPa) and high-level scratch hardness (up to 2 GPa). The hybrid coatings were also studied during a prolonged exposure to UV–vis light, with the aim of testing outdoor durability and correlating the scratch resistance with possible chemical modifications and wettability behavior. All the
coatings exhibited excellent stability and an overall increase in scratch resistance over long-term light exposure. The hybrid coatings with the low and intermediate content of zirconia investigated showed a smooth surface even after a prolonged light exposure, while maintaining high-level scratch hardness of nearly 2.5–3 GPa. Conversely, the reference polycarbonate substrates underwent significant photo-degradation and a reduction in their scratch hardness by increasing light exposure time was observed. The results of this work suggest that silica/zirconia fluorinated hybrids have great potential as hard scratch resistant coatings on plastics in many technological fields, e.g. touch-screen devices, photovoltaic and optical devices, automotive components [2] and also offer remarkable durability in a straightforward way without requiring complicated procedures or expensive instrumentation for their preparation.


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NANO-150

Integration of quantum dot sensitized solar cells on technical textiles

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In the field of energy conversion wind power, tidal power and solar cells have been established. Non-classical solar cells can be subdivided in dye-sensitized, perovskite, organic, hybrid and quantum dot sensitized ones. With regard to quantum dot sensitized solar cells (QDSSC) advantages like a tunable absorption region due to quantum dot size and multi exciton generation are used. So far efficiencies up to 9.5 % have been reached [1]. In most cases the published solar cells are fabricated on solid substrates and completed with a liquid polyelectrolyte.

For the preparation of our QDSSC, PES-Silicone substrates were chosen as a technical textile which can be found on solar panels, truck tarpaulins and window shades. On these substrates, we prepared active layer stacks without using a liquid polyelectrolyte, because this is not favoured for integration on highly-flexible textiles due to leakage reasons. This work focuses on two solid layer stacks: a) a hybrid solar cell consisting of a conductive polymer and P3HT/quantum dot composite [2] and b) a complete inorganic layer stack consisting of metal oxides and quantum dots [3]. First samples on PES-Silicone-substrates have been realized. At the moment the maximum power conversion efficiency of the as prepared solar cells is still lower than conventional ones but by optimizing layer composition and increasing the functional area of the cell an efficiency of up to 2 % on highly-flexible substrates are expected. In the future, the integration of quantum dot sensitized solar cells on technical substrates could lead to energy support for various devices such as on-bord electronics and autonomous control of window shades.

NANO-152

Substrate Induced Structural and Optical Changes in Thermally Deposited Thin Films of Lead (II) tetrakis (4-cemylphenoxy) phthalocyanine

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In the present work, thin films of Lead(II) tetrakis (4-cemylphenoxy) phthalocyanine of different thicknesses ranging from 20 nm to 100 nm were deposited by thermal evaporation under a residual air pressure less than 10^-6 mbar on glass and transparent flexible (overhead projector sheets, OHP) substrates, at room temperature. The prepared films were characterized for structural, morphological and optical properties by X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), atomic force microscopy (AFM), UV-Vis and Raman spectroscopy. The films exhibited a change over from amorphous to crystalline structure on changing the substrate from glass to OHP sheet respectively [1]. Pb (ii) Pc films made on flexible substrate showed enhanced porosity relative to films on glass substrates, which, in turn, further increased with film thickness, opening up its avenues in the field of gas sensors.


NANO-153

Producing and Characterization of V_2O_5 Nanobelts with a One-Step Method

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The synthesis and characterization of 1-D nanostructured transition metal oxides has received considerable attention due to their novel application. Among them, Vanadium oxide shows particularly rich chemistry because of the tunable vanadium oxidation state (from +2 to +5) and flexible coordination environment. Because of these, V_2O_5 has been attracted much interest owing to its excellent properties for various important applications such as actuators, sensors, catalysis, transistors, solar cells, electro-chromic devices and high energy density lithium ion batteries. In this study, V_2O_5 nanobelts is successfully produced with a novel ultrasound assisted solution treatment method using commercial V_2O_5 powders as the precursor. These nanobelts show remarkably large surface area by comparison with V_2O_5 precursor. Binder free and flexible free-standing electrodes are prepared by the inter twining V_2O_5 nanobelts. Nanobelts are characterized by FESEM, AFM, X-ray diffraction and N_2 adsorption/desorption analyze.
NANO-154

Detailed analysis of hydrothermally grown ZnO nanorods on the graphene oxide sheets

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Zinc oxide (ZnO) is a potential semiconductor material with amazing optical and electrical property. Because of the superior electrical conductivity of ZnO, it is widely used in many applications ranging from optoelectronics, gas sensors, energy storage and solar cells [1]. Graphene is a single 2D carbon sheet with large specific surface and excellent electric conductivity [2]. In this paper, ZnO nanorods/graphene oxide heterostructure was synthesized by hydrothermal growing ZnO nanorods on graphene oxide film. Graphene oxide was prepared through modified Hummer's method as described in the literature [3]. Zinc acetate/ethanol solution was used to produce seed layer on the graphene oxide sheets. Then ZnO nanorods were grown on the film in a solution containing equimolar concentrations of zinc nitrate hexahydrate (Zn(NO3)2·6H2O) and hexamethylenetetramine (C6H12N4, HMTA) at 90 °C for 1 h. The ZnO-nanorods/graphene heterostructure was characterized by field emission scanning electron microscopy (FE-SEM) and X-ray diffraction (XRD, Cu Kα radiation).


NANO-155

Synthesis and Characterization of ZnO-Graphene Oxide Nanocomposites

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Graphene Oxide (GO) is a compound of carbon, oxygen, and hydrogen in variable ratios. Among them, chemical reduction of exfoliated graphene oxide (GO) sheets was found to be the most versatile and scalable [1]. Zinc oxide (ZnO), a semiconductor with a direct wide band gap (3.37 eV at room temperature) and large exciton binding energy (60 meV) [2, 3], is one of the most promising materials for applications in catalysts, sensors, piezoelectric transducers, transparent conductors, and surface acoustic wave devices [3]. With this unique property, ZnO has also attracted attention for electrical and optical applications such as light-emitting diodes, photo-catalysts, photodetectors, solar cells, piezoelectronic devices, and sensors. In this study, ZnO/graphene oxide nanocomposite was synthesized by hydrothermal route using graphene oxide and ZnO precursor solution. Graphene oxide was prepared through modified Hummer's method as described in the literature [4]. Synthesized ZnO /Graphene oxide nanocomposite was characterized using a field emission scanning electron microscope (FESEM), X-ray diffraction (XRD), and energy dispersive spectroscopy (EDS).
We propose the use of nanotextured interfaces in view of light manipulation in optoelectronic and photovoltaic devices. The final aim is to achieve light coupling across interfaces of dissimilar material employed in photonics devices exploiting broadband light scattering properties of one-dimensional pseudo-periodic self-organized gratings. We experimentally demonstrate large area (cm$^2$) and high aspect-ratio nanopatterning of substrates by recurring to de-focused ion beam sputtering (IBS) through a self-organised sacrificial Au nanowire stencil mask. These nanoscale features, can be obtained on different substrates ranging from glass, transparent conductive oxides, metals and crystalline semiconductors like Si and GaAs. Textured substrates have been characterized from the morphological and optical point of view by means of an AFM microscope and an integrating sphere, respectively. Morphological parameters have been employed to simulate and analyze the optical response of textured glass by recurring to 3D finite difference time domain (FDTD) method. Pseudo periodic one-dimensional nanostructures endowed with high aspect ratio proved numerically and experimentally to be effective in view of broadband diffuse scattering of radiation. Haze values (around 30%) higher than commonly employed light trapping reference materials are reported. Thin film solar cell based on the nanostructured pattern has been numerically studied for broadband absorption enhancement using the 3D FDTD and compared with the experimental outcome of physical devices. Tangible absorption enhancement is reported in nanostructured devices relative to the conventional flat thin film solar cell. The optimized SC can offer a short circuit current of 13.8 mA/cm$^2$ with an enhancement of 21% over the SC without textured surface.

Rigged polydimethylsiloxane (PDMS) nanopatterned templates are formed by uniaxial wrinkling following air/Ar ion plasma treatment on pre-stretched samples. PDMS undulations with height to width aspect ratios in the range of 1, remarkable long-range order and periodicity from 300 nm to above one micrometer are so achieved. Alternatively, PDMS templates are formed by soft lithography using nanostructured glass substrates (masters) made by defocused Ion Beam Sputtering (IBS). The glass masters exhibit a regular and tunable undulated pattern with periodicity well below 300 nm, and a higher aspect ratio compared to pre-stretched PDMS samples, which is successfully transferred to the polymer slave. The uniaxial PDMS modulations represent a natural platform for the confinement of plasmonic nanostructures when thermal deposition of Au is performed at grazing incidence. In this way Au nanowire arrays (NWs) endowed with monodisperse width distribution and length exceeding several tens of micrometers are formed. The NWs exhibit a strongly dichroic optical response due to the excitation of Localized Surface Plasmon Resonance (LSPR) when light is polarized orthogonal to their axis. The resonant wavelength can be tuned across the VIS-NIR spectral region by acting on the NWs width (140-250nm) and on the periodicity and aspect ratio of the flexible PDMS template. For light polarization parallel to the NWs axis, the optical spectrum is instead analogous to that of a continuous film, thus conferring to the NW array the performance of an IR wire grid polarizer. The tunability of the LSPR response can be exploited in order to match the pump laser in plasmon-enhanced spectroscopies. Test measurements demonstrate e.g. that Raman-SERS enhancement factors above $10^4$ are easily achieved. Also relevant is the performance of the NWs as conductive electrodes with sheet resistances in the range of 10-20 Ohm/sq which candidate Au/PDMS nanowire arrays as transparent electrodes for flexible applications.
characteristics are modified by the gas reactivity on the porous silicon/polythiophene surface. The sensor shows a rapid and reversible response to low concentrations of the gas studied at room temperature.

NANO-160

Towards a 3D Isolation of Semiconductor Nano-Box by Ion Implantation

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Ion implantation is routinely used to create doped regions that act as active channel layers or contacts in semiconducting materials. Here, we address an opposite attribute of ion irradiation: formation of insulating regions by damaging the crystal with electrically inactive projectiles. The first aim of this study was to develop a buried, highly damaged, planar layer by proton implantation with doses of ~10^{17}/cm^2. The investigated semiconductors were: GaAs, InP, GaSb, CdTe, ZnO and GaN, representing different crystal structures, band-gaps, and radiation hardness. The employed analytical methods included SIMS, RBS-C, TEM, and SEM. Annealing of all implanted III-V compounds resulted in the formation of a localized layer, consisting mainly of cavities or bubbles filled with hydrogen. Similar proton implantation applied to silicon, can lead to exfoliation and transfer of a thin crystalline Si film to another substrate in a process known as Smart Cut™.

In our investigation, we have focused on proton-implanted gallium nitride and electrical properties of the associated buried cavity layer. The concept relies on reduced defect production in the near-surface film where light H^+ ions lose energy predominantly in electronic collisions, and on the accumulation of defects occurring near the ion projected range that is determined by the implantation energy. As a result, after appropriate annealing, the resistivity of the surface film is restored to its initial value while the resistance of the buried layer rises by 4 orders of magnitude as measured on a special step-like structure.

To completely isolate a small volume of GaN, vertical isolation was added by a low-dose implantation of Al^+ ions through a metallic mask, yielding a very high resistivity around semiconducting “nano-boxes.” Implant isolation retains the planarity of the surface for subsequent resist application and metal step coverage giving a significant advantage over chemical mesa etching. In addition, it reduces undercutting effects, thereby allowing for shrinking of the pattern sizes. In conclusion, we propose a new scheme of 3D electrical isolation of a semiconductor volume for electronic, photonic or spintronic discrete devices.
**NANO-161**

### SnO$_2$ Based Carbon Composite Electrodes for Li-ion Batteries

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Li-ion batteries have high specific energy in the energy storage technologies. Production of Li-ion batteries and electrodes with high performance has gained importance in recent years with the increased interest to the energy field [1]. SnO$_2$ is very attractive electrode material because of its high theoretical capacity (1491 mAhg$^{-1}$), good cyclability and high columbic efficiency [2]. During charge/discharge process, volume expansion and pulverization have occurred in the SnO$_2$ electrodes materials in addition to their superior properties. To overcome this problem, forming composite structure with carbon based materials is a efficiency way. Carbon with different forms (graphene, carbon nano tube, carbon fiber etc.) is suitable materials in electrochemistry applications because of its mechanical properties and its high chemical stability in acidic or basic solutions at a wide temperature range [3]. In this study, good cycling properties are achieved by using MWCNTs as a substrate for nanocrystalline SnO$_2$ prepared through a facile sol-gel technique. The composites are characterized by FESEM, X-ray diffraction and thermogravimetric analyze. SnO$_2$/MWCNT composites are used as anode in Li-ion batteries. The electrochemical characterization tests including charge/discharge performance, cyclic voltameter and electrochemical impedance spectroscopy (EIS) measurement of cathodes are carried out by using an 2016 coin cells.


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**NANO-162**

### 3D Reconstruction of SEM Images of Adipose Tissue

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Adipose tissue has recently been described as an endocrine organ [1]. The development of it characterization is still a challenging issue. The improvements in the detection of microstructures of varied materials with opening the new areas of applications provide a strong motivation for studying electron microscopy data processing possibilities. Till now the suitable models for the extrapolation of three-dimensional sample data out of the
SEM images are lacking, and consequently, the precise qualitative and quantitative microstructural analysis is still an open question.

In the present work, SEM images were used to reconstruct a 3D view with an open source program VisualSFM. For the primary work, very characteristic AgNO₃ particles (cubes and tetrapods) were selected to get acquainted with the program. Then the database of SEM images of the adipose tissue taken from 3 layers of adipose tissue (subcutaneous, preperitoneal and visceral) was collected. The most characteristic examples were selected for 3D reconstruction. The key steps and 3D reconstruction model will be presented during the talk.


NANO-165

Ultra-fast nano-organization of carbohydrate-based block copolymer thin films with sub-10 nm features

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Block copolymers (BCP) have attracted considerable research attention and industrial development due to their capability of forming long range ordered patterns at the nanometer scale. Hydrophilicity-hydrophobicity imbalance could result in high incompatibility between saccharides and synthetic polymers, which is exploited by our group to study natural-synthetic hybrid BCPs with a high $\chi$ parameter.

The natural-synthetic hybrid BCP polystyrene-block-maltoheptaose (PS-b-MH) used in this study is synthesized by linking end-functionalized blocks via click chemistry. The PS-b-MH can self-assemble into hexagonally close-packed cylinder patterns with sub-10 nm feature size, which exhibits for example high performance in nonvolatile transistors memory applications. Here we report that how to archive self-assembly of PS-b-MH thin films in few seconds by a so called high temperature solvent vapor annealing method using microwave energy. As opposed to conventional solvent vapor or thermal annealing processes (taking few hours), ultra-fast (1 sec) self-assembly of high-$\chi$ carbohydrate-based block copolymers (BCP) thin films leading to nanoscale patterns (sub-10 nm perpendicular or horizontal cylinders) was achieved. Such new technological approach is of great interest for a wide variety of applications in the semiconductor industry.

Spatially distributed passivation as a tool for new materials. Cellular automata modelling.

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We apply a 3D cellular automata model of aqueous corrosion [1] to a metal surface with periodically distributed oxide patterns. The corrosion model [2] takes into account diffusion, neutralisation reactions in solution and separate anodic and cathodic electrochemical reactions on the metallic surface with electrical transfer. Oxide patterns induce localised cathodic zones [3] associated to basic solution. Neighbouring zones are acidic and remain stable due the autocatalytic property of the anodic half-reaction and slow neutralisation between acidic and basic regions which proceeds only at the interface between acidic and basic regions. The spatially inhomogeneous electrochemical reactions lead to inhomogeneous corrosion rates with consequences on the morphology. The work highlights strong correlation between morphology and corrosion kinetics and induced 3D structures from the 2D initial surface patterning. A paradoxical response is evidenced. Starting from small oxide patterns, the more we passivate the surface, the more we increase the corrosion rate until oxide patterns are sufficiently large to protect the metal. This work can help the design of bio-degradable materials [4].


Catalytic Removal of Food Waste Derived Odor using Hybrid System Comprised of Wet Plasma and Catalyst

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The efficient removal of odor has been an important topic in the area of environmental catalysis research. Especially, efficient removal of food waste derived odor has been a significant problem of Korea government to enhance quality of life. Although the general method to treat food waste derived odor is adsorption, the
efficiency is low. In addition, the catalytic control can be applied at lower temperatures compared with thermal oxidation alone. However, in most cases the reaction temperature of catalytic reaction is higher than 200°C. To reduce the operating temperature of odor removal to room temperature, ozone should be used. In this study, we developed a new hybrid system comprised of wet plasma and catalyst to remove food waste derived odor. Mn or Cu coated catalysts such as Mn/natural zeolite, Cu/natural zeolite, Mn/HY, and Cu/HY have been used as catalysts. Ozone can be produced from wet plasma. The catalytic odor removal efficiency was greatly increased with ozone generated from wet plasma at room temperature. The detailed reaction mechanism will be suggested. This research was supported by Nano-Material Technology Development Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT and Future Planning (No. NRF-2015M3A7B4049714).

NANO-169

Efficient Upgrading of Bio-oil using Porous Catalytic Materials

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Bio-oil produced from the pyrolysis of biomass or lignin has several drawbacks, such as low heating value, high oxygen content, and low pH. Meanwhile, catalytic fast pyrolysis of biomass results in a bio-oil with reduced oxygen content and increased heating value compared to the bio-oil obtained from original biomass. Recently, many different catalysts have been investigated to produce highly qualified oil. Especially, to produce highly stable oil, surface modification of catalyst is necessary. In this regard, we applied many different catalysts such as carbon, metal oxide, and zeolitic materials. Carbon catalyst prepared from char was applied to catalytic fast pyrolysis. Surface of char was modified by steam, KOH, H₂SO₄ treatment. Also, metal oxide catalysts such as alumina which were prepared from different methods were applied to catalytic fast pyrolysis of lignin or other biomass. Metal loaded zeolites were also used. Characterization of the catalysts was performed using N₂ adsorption-desorption, XRD, FT-IR, and NH₃ TPD. In the case of catalytic fast pyrolysis of biomass, the yields of light phenolic compounds and aromatic compounds were increased compared to that of non-catalytic fast pyrolysis. The detailed reaction analysis and mechanism will be suggested. This work was supported by the New & Renewable Energy Core Technology Program of the Korea Institute of Energy Technology Evaluation and Planning (KETEP), granted financial resource from the Ministry of Trade, Industry & Energy, Republic of Korea. (No. 20153030101580). Also, this work was supported by the National Research Council of Science & Technology (NST) grant by the Korea government (MSIP) (No. CAP-11-04-KIST).
Tyrosinase immobilization on functionalized porous silicon surface

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In this work, we studied the attachment of active Tyrosinase enzyme on porous silicon (PSi) substrate as a potential biomarker for the detection of phenolic derivatives. A multistep functionalization strategy was developed [1]: acid chains were covalently grafted on the hydrogenated PSi by hydrosilylation reaction. The obtained acid-terminated surface was activated by a reaction with N-hydroxysuccinimide (NHS) in the presence of a peptide-coupling agent N-ethyl-N’-(3-dimethylaminopropyl)-carbodiimide (EDC), and then reacted with the amino linker of the lysine residues tyrosinase to enhance the enzyme by a covalent amide bond. Fourier transform infrared spectroscopy (FTIR) confirmed the efficiency of the surface modifications. The surface was characterized with contact angle measurements as well. The enzymatic activity of immobilized Tyrosinase was determined by means of a colorimetric assay based on the assessment of the UV/Vis absorbance at 500 nm of a brown product resulting from the enzymatic oxidation of Pyrocatechol to O-quinone which is transformed to a brown pigment with the presence of 3-methyl-2-benothiazolinone (MBTH) reagent. The results showed the attachment efficiency of Tyrosinase enzyme on functionalized PSi surface. Moreover, the enzymatic activity of Tyrosinase was preserved after immobilization; the surface concentration of active Tyrosinase was estimated to be $\Gamma = 1.135 \times 10^{15}$ molecules covering the whole PSi surface.


Non-invasive Detection of Cancer from Urine using Nanotextured Polymer Biochip

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Bladder cancer is known for its high recurrence rates and low sensitivity, which requires the patients to undergo invasive and expensive diagnostic methods. A novel approach is presented that can detect bladder cancer non-invasively by isolating the tumor cells that are naturally exfoliated into the urine. The human lung cancer cells (A549) were used as model cells. These were captured on a nanotextured polymer biochip that was functionalized to specifically target the surface EGFR overexpressed biomarker that is also present on the bladder cancer cells [1].
The nanotextured PDMS biochips were fabricated by molding them off the unpolished side of a standard silicon wafer. The microfluidic network pattern was 3D printed and transferred to PDMS by replica molding. The nanotextured PDMS substrates, modified with neutravidin-biotin functionalization, were sandwiched in a Sealed, Easily-Accessible, Modular (SEAM) microfluidic architecture. The SEAM was essentially PMMA housing assembly that held all the pieces together with the help of magnets.

The A549 cells were suspended in healthy human urine sample for capture tests. Anti-EGFR antibody and an isotype IgG1 antibody (control) were used on the substrates. The isotype antibody did not have any affinity for the tumor cells. After sealing the biochip, cells were introduced through the inlet port of the microfluidic network and allowed to incubate before washing and imaging [2]. The capture efficiency was found to be about 5 times greater on the anti-EGFR antibody coated chip than the control. The cancer cells were thus successfully captured from urine. The SEAM assembly can be used to test patient urine samples and our goal is to detect low grade bladder cancer with high sensitivity.


NANO-175

Electrical Differentiation of Metastatic and Non-Metastatic Tumor Cells from Individual Morphological Characteristics

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Cancer is one of the leading causes of human mortality. The mortality rate due to cancer has not decreased as much as other diseases, over many decades, even though the medical technology has radically improved. This is due to cancer being a silent killer, which does not show any significant symptoms in the early stages of the disease. It can be treated with higher survival rates in the early stages. Early stage cancer detection is thus necessary. For an example, stage 1 breast cancer detection has almost 100\% five-year survival rate but as the cancer matures into stage 4, the five-year survival rate goes down to just 22\% [1].

The journey of cancer from non-metastatic to becoming metastatic is not well understood. The cancer cells slowly morph into metastatic cells and spread throughout the body. Understanding the changes in cellular physiological and morphological characteristics can help in its early detection. Also, the detection of metastatic cells in blood and biopsy samples can be used to control the parameters of treatment and determine the efficacy of treatments. It is thus important to reliably quantify non-metastatic tumor cells (NMTCs) and metastatic tumor cells (MTCs) in patient samples for early detection, better cancer staging and effective treatment.

We fabricated solid-state micropores made in 200 nm thin SiO\textsubscript{2} membranes. Each micropore membrane was packaged such it separated two containers of ionic solution and breast cancer cells were translocated through. The drop in ionic current as the cells translocated across the micropores were measured as pulses. The mechano-physical differences in the morphological characteristics of NMTCs (MDA MB-231 cells) and MTCs (MCF7 cells) gave different and distinct pulse characteristics [2]. These differences were because of the variation in cellular properties like deformability, elasticity, strain energy, and motility. The device detection efficiency for NMTCs and MTCs was ~75\%. The MTCs caused ~35.6\% less pore ionic current blockage and
took ~37.5% less translocation time compared to the NMTCs. This showed that the MTCs were significantly more elastic than the NMTCs which made them ideal to spread throughout the human body leading to higher stage of the cancer.


**NANO-176**

*In vitro Evaluation of Modified Nanohydroxyapatite Doped Electrospun Nanofibrous Scaffold*

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Electrospinning technique has been satisfactorily utilized to prepare osteoconductive Polycaprolactone (PCL)/Elastin (ELS) based nanofibrous scaffolds. First of all, nanohydroxyapatite particles (NHAp) were obtained by sol gel method. Following, surface of NHAp were modified with different molecular weights (200, 400, 600) of Polyethylene glycol (PEG) in order to gain more hydrophilic particles. Then, various PCL/ELS nanofibrous scaffold structures including unmodified and modified NHAp were fabricated. Diameter and morphology of NHAp and electrospun nanofibers were observed by SEM analysis. Structural properties of the scaffolds were characterized by FTIR. Biocompatibility of the scaffolds was determined by XTT test using human osteoblast cell lines (MG-63). In addition, Bradford method was applied to determine the total amount of protein in living cells. Results proved that none of the single PCL and composite scaffolds presented cytotoxic effect.

**NANO-178**

*Nano silver particles infiltrated three-dimensional crimped silk yarn*

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This paper works on producing a kind of nano silver particle infiltrated 3-D crimped silk yarn. A 3-D crimped yarn first made from traditional silk yarn, and then nano silver particles are in situ reduction. Nano silver particles were on the surface and interior of 3-D crimped silk yarn. Finally, nano silver particles on the surface was removed together with sericin. Most of the nano silver particles were in the interior of silk yarn. Therefore,
the nano silver particles infiltrated silk yarn have a smooth surface while better antimicrobial properties. The research provides a new method to produce a functional silk yarn.


NANO-179

Study of the Thermal Drift in Sensitivity of Pressure Sensor

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In this work, a numerical model to ameliorate the pressure sensitivity of sensor has been developed. We determine the effect of temperature in the pressure sensitivity in this sensor during the applying a supply voltage. In the other hand, the evolution of sensor sensitivity has been computed as function of supply voltage, as well as, for different times, for various geometrical parameters of the sensor. It has been observed that the sensitivity is greatly affected by the rise in the supply voltage, mainly when the sensor is operated in the prolonged time. Finally, this paper allows us to evaluate the reliability of sensors. It also, permits to predict their behavior against temperature due to the application of a voltage of a bridge and to minimize this effect by optimizing the geometrical parameters of the sensor and by reducing the supply voltage.

NANO-180

Synthesis and Characterization of TiO$_2$: Nb$_{4-x}$V$_x$ thin film deposited by ultrasonic spray pulverization for solar cells applications

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Titanium dioxide (TiO$_2$) is a semiconductor with a large band-gap (anatase, $E_g = 3.2$ eV). Furthermore, TiO$_2$ has high transparency for visible light, large value of the refractive index ($n = 2.52$), controllable specific resistance, good adhesion and high chemical resistance. TiO$_2$ has a large variety of potential applications. In this paper Nb$_{4-x}$V$_x$ Co-doped TiO$_2$ thin films were synthesized at different x.at% (x=0.1,2.3,4) on quartz and silicon substrates by chemical ultrasonic spray method. Tetra iso-Propoxide Orthotitanate Titanium (TPOT) was used as a precursor, Niobium iso-Propoxide as the Nb source, and Vanadium triso-Propoxide as the V source. The as-prepared films are annealed in N$_2$ atmosphere at 600°C for 30 min. The samples are characterized by X-ray diffraction (XRD), Raman, ATR-FTIR, UV–Vis transmission and diffuse reflectance spectroscopy (DRS) and photoluminescence spectroscopy (PL). The results obtained show that the films properties are largely influenced by the nature, mixture and the concentration of the dopant.
Enhanced Dielectric Permittivity in Nano Ag-Deposited (In$^{3+}$, Nb$^{5+}$) co-doped TiO$_2$/Polyvinylidene Fluoride Composites

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In this work, nano Ag-deposited (In$^{3+}$, Nb$^{5+}$) co-doped TiO$_2$ (Ag-INTO) hybrid particles are prepared by a seed-mediated growing process by a redox reaction between silver nitrate and ethylene glycol. Ag-INTO hybrid particles are used as fillers for fabricating flexible polymeric composites to enhance dielectric permittivity and retain low dielectric loss tangent of polyvinylidene fluoride (PVDF). Nano-Ag particles deposited on INTO surface are revealed by a transmission electron microscopy. Ag-INTO/PVDF composites are fabricated by conventional mixed powder and hot pressing methods. The dielectric properties as functions of frequency and temperature were investigated. Enhanced dielectric permittivity of $\approx 10^2$ and low loss tangent of $\leq 0.1$ in a low frequency range are successfully achieved by optimizing loading content of Ag-INTO filler. The discrete growth of Ag nanoparticles on INTO ceramic particles efficiently prevented the continuous contact between Ag metallic particles in the PVDF matrix. This can suppress the formation of the conducting path in the composite, resulting in a low loss tangent and conductivity [1].


CaCu$_3$Ti$_4$O$_{12}$ Nanopowders Prepared by a Urea–Combustion Method: Synthesis, Characterization, and Their Bulk Electrical and Giant Dielectric Properties

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In this work, CaCu$_3$Ti$_4$O$_{12}$ nanopowders are successfully prepared by a urea–combustion method. Nanocrystalline CaCu$_3$Ti$_4$O$_{12}$ particles are revealed by a transmission electron microscope. A main phase of CaCu$_3$Ti$_4$O$_{12}$ is detected in all powder samples. The effects of sintering conditions on microstructure, giant dielectric properties and nonlinear current–voltage characteristics of bulk sintered ceramics are systematically investigated. Fine–grained CaCu$_3$Ti$_4$O$_{12}$ ceramics with highly dense microstructure are accomplished. Very
high dielectric permittivity values of \( \sim 10^3 \)–\( 10^4 \) with very low tan\( \delta \) \( \sim 0.03 \)–\( 0.11 \) at 1 kHz are achieved. Interestingly, large values of breakdown electric field (\( E_b \sim 9741.62 \) V/cm) and high nonlinear coefficient (\( \alpha \sim 9.86 \)) are also obtained. The oxidation states of Ti and Cu ions were confirmed by using X–ray absorption spectroscopy. The origin of the giant dielectric response and nonlinear electrical properties is discussed in details.

NANO-187

PA6/Silver blends: Investigation of Mechanical and Electromagnetic Shielding Behaviour of Electrospun Nanofibers

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Nanotechnology has gained an importance in a number of areas such as energy science, mechanics, electronics, optics, space industries, optoelectronics, nonlinear optical devices and light emitters applications. Polymer nanofibers are increasingly used for a wide range of applications because of their high specific surface area. Polyamide-6 (PA-6) nanofibrous membranes with 1\%, 3\%, 5\% and 8\% nano-silver were produced successfully. It was aimed to obtain electromagnetic shielding with the functional nanofibrous membranes. The electrospinning solutions’ properties were determined with pH values, conductivity and viscosity. Morphology of the membranes was examined with Scanning Electron Microscope (SEM) and determination of elemental composition of the nanofibrous membranes was conducted with Energy Dispersive Spectroscopy (EDS) analysis. The mechanical properties of the electrospun nanofibrous samples were also investigated. Electromagnetic shielding effectiveness (EMSE), absorption (Ab) and reflection (Re) properties of these nanofibrous membranes were measured in the frequency range of 15-3000 MHz according to coaxial transmission line method specified in ASTM D4935-10.
Large Scale and Facile Synthesis of Sn Doped TiO2 Aggregates using Hydrothermal Synthesis

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In material science, recent progress is mainly devoted to develop innovative strategies to prepare nanomaterials with desired properties, which are a coupling of both its intrinsic and extrinsic properties. Among the strategies reported for extrinsic material properties control, nanoparticles agglomeration appears to be a promising approach to obtain materials with controlled architectures and desired properties for targeted applications. In fact, combining a mixture of nanoparticles with different physical and chemical properties offers a large number of possibilities to tailor the properties of agglomerated materials \cite{1,2}.

Sn doped TiO\textsubscript{2} aggregates have been successfully prepared via one pot hydrothermal technique. It was illustrated that the size, the morphology and the phase of prepared TiO\textsubscript{2} aggregates is strongly influenced by the amount of added Sn doping. In addition, it was demonstrated that the prepared aggregates properties is influenced by the synthesis temperature. Furthermore, it was shown that the prepared Sn doped TiO\textsubscript{2} aggregates are of high crystallinity. The influence of added Sn dopant amount on the optical and structural properties of the prepared Sn doped TiO\textsubscript{2} aggregates have been investigated.

\cite{1} A. Taleb, F. Mesguich, X. Yanpeng, C. Colbeau-Justin, P. Dubot, J. SOLMAT, 52, 148 (2016).

Pressure-responsive Locomotion and Its Potential Application in Powering Cardiac Pacemaker

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One big challenge in the practical use of cardiac pacemaker is the limited lifetime of battery. Once the battery runs out, a surgery to replace the battery is necessary, which increases the cost and even bring risk to patients \cite{1,2}. To handle this problem, various biomechanical energy has been proposed to be converted to electric power by implanting an energy-harvesting device onto the outside surface of the heart \cite{3-6}. Therefore, to realize energy harvest from the heart without damaging the tissue, we have fabricated a pressure-responsive device consisting
of a cooper foil with cylindrical shape and a solenoid coil. This device could respond to the pressure difference of 40 mmHg and perform a diving-surfacing cycled locomotion, which further converted the obtained mechanical energy to electricity with a maximum output of 36.5 $\mu$W according to the Faraday's law of electromagnetic induction. Furthermore, we have connected the pressure-responsive system to the artery of a live ewe and its blood pressure caused by heartbeat induced the internal pressure difference of the electricity-generating system. When the system is open to the artery of the ewe, the systolic blood pressure and diastolic blood pressure allow the diving-surfacing cycled locomotion of a device, and the obtained mechanical energy can be converted to electricity. Hence, we have successfully harvest biomechanical energy available from live animal to electricity energy, which could be used as sustainable power supply.


NANO-190

Electrochemical sensors performance: The role of specific surface and recognition receptors dynamic

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Toxic substances such as heavy metals are dangerous for human health and environment at a certain concentration threshold depending on their poisoning mechanism. Toxicity is a function of their degree of solubility and biodegradability. Insoluble substances as well as the metallic forms, exhibit negligible toxicity in most cases. For non-biodegradable substances, their accumulation in living organisms over a lifetime contact induces the increase of their concentration which may exceeds the tolerated threshold limit. Human contamination by heavy metal even at a trace level induces a dysfunction and serious damages to many body systems [1]. For human safety, there is an urgent need to specify tolerance threshold and to develop performing tools for their detection and control. A comparison of electrochemical sensor performances is achieved using self-organized gold nanoparticle (Au NP) modified HOPG electrode and thin gold film as electrode materials. Both electrode surfaces were functionalized with bisphosphonate receptors (BP) [2]. In addition, performances comparison between modified electrode with and without BP receptors is achieved. The obtained results show a detection limit of 0.5 $\mu$M for nanomaterial electrode sensor, whereas for thin film electrode sensor it is about 10 pM. These results were discussed in terms of electrode specific surface and recognition receptors dynamic.

Three-Phase Polyvinylidene Fluoride/Ag-La$_{1.9}$Sr$_{0.1}$Ni$_{0.6}$Mg$_{0.4}$O$_4$ Nanocomposites With Enhanced Dielectric Properties and Low Dielectric Loss

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Polymer composite materials have been widely studied in recent years due to the need for flexible materials with outstanding properties that can be integrated into a variety of flexible electronic devices and for supporting the rapid progress of electronic industry [1]. In the present work, three-phase polymer nanocomposite with enhanced dielectric permittivity and low dielectric loss is presented. Nano Ag-La$_{1.9}$Sr$_{0.1}$Ni$_{0.6}$Mg$_{0.4}$O$_4$ (Ag-LSNMO) hybrid particles were synthesized using a seed-mediated growth technique. The PVDF/Ag-LSNMO nanocomposites were fabricated by a liquid-phase assisted dispersion and hot-pressing methods. The dotted Ag on the surface of LSNMO efficiently prevented the continuous contact between Ag particles in the PVDF matrix and suppressed the formation of the conducting path in the composite. The three-phase composite exhibited good flexibility due to the low concentration of fillers and very low dielectric loss. As a result, with a filler loading of 17.55 vol%, the composite displayed a dielectric constant ($\varepsilon'$) value of 61.9 and dielectric loss (tan$\delta$) of 0.027 at 1 kHz. These findings demonstrating promising applications in the electronic devices.


Functionalized nanoparticles for CO2 sensor

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Energy consumption due to heating and ventilation processes in buildings represents a non-negligible portion of the total energy spent for the indoor sector. Therefore, solutions to manage energy efficiently and to ensure a good air quality inside buildings have to be found. The main task of our work is to realize a novel CO2 chemical sensor, which should work within a Heating Ventilation Air Conditioning (HVAC) system. In the field of chemical gas sensors, a conventional way to detect CO2 is based on optical method using a non-dispersive Infrared spectroscopy, which suffer from a high-energy consumption. Until today, there is a lack of sensitive, reversible and stable chemical gas sensors for CO2, which allow size reduction, are able to operate at moderate temperature less than 70°C and are cheap to be spread in indoor applications, such as HVAC systems. Our chemical CO2 sensors consist of an interdigital transducer (IDT) with a comb like periodic pattern of
electrodes on glass substrate. A heater and temperature sensor are designed around each IDT chip. A newly developed hybrid material, based on amine functionalized silica nanoparticles, is used to sense CO2 [1,2]. A simple coating technique is used to deposit the sensing layer onto the interdigitated electrodes. The sensing mechanism is based on the change of the dielectric properties of the sensing material due to an adsorption and diffusion of the CO2 molecules into the sensitive layer. The operating temperature have been optimized to reach the best compromise between high sensitivity, fast response/recovery times, selectivity and stability.


**NANO-197**

**Bismuth Telluride Thin Films with a High Thermoelectric Power Factor**

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Thermoelectric thin films were explored to provide a flexible thermoelectric generator. Highly conductive n-type Bi$_2$Te$_3$ films on an insulative flexible substrate were prepared via electrodeposition followed by a dry transfer process. The growth of the Bi$_2$Te$_3$ was precisely controlled by an electrochemical deposition potential ($V_{dep}$), which was critical to the preferred orientation of the crystal growth and thus to the properties of a flexible thermoelectric generator (FTEG). A Bi$_2$Te$_3$ film prepared under $V_{dep}$ of 0.02 V showed high electrical conductivity with a maximum power factor of 1473 $\mu$W m$^{-1}$ K$^{-2}$ [1]. As-prepared FTEG was bendable, showing only a small resistance change after 300 repeated bending cycles. As a p-type thermoelectric film, poly(3,4-ethylene dioxythiophene)s (PEDOT) films were prepared by the solution casting polymerization on an insulative flexible substrate to afford a thin thermoelectric film with a high electrical conductivity, high Seebeck coefficient, and power factor [2]. The thin PEDOT films could be processed as flexible film and rolled up for a roll-type thermoelectric leg to generate electricity. Combined with the n-type Bi$_2$Te$_3$ FTEG, a prototype p,n-type flexible thermoelectric (pn-FTEG) was prepared to give multi-couple FTEG with a high output voltage and output power in a bending state. Structural control in the thermoelectric films and examples of flexible TEGs based on these thermoelectric films will be presented.

ELECTROCHEMICAL SYNTHESIS AND MICROSTRUCTURAL ANALYSIS OF ZnO NANOSHEETS FOR PHOTOCATALYSIS

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ZnO has many potential applications in sensing, photocatalysis and solar cells [1], due to its possession of unique properties such as near-UV emission, optical transparency, electric conductivity, piezoelectricity and photocatalytic properties [2,3]. In this paper, we report the preparation of ZnO nanosheets onto indium tin oxide (ITO) substrate by cathodic electrodeposition in an aqueous solution of zinc nitrate and potassium chloride - this later acting as a capping agent promoting nanosheets formation - followed by annealing at 400°C for 60 min. The deposits were characterized with scanning electron microscopy (SEM) to determine the morphological properties. The XRD patterns of these films revealed the existence of polycrystalline hexagonal wurtzite phase with c-axis orientation of crystallites. The crystallite size, lattice strain and stress and the density of dislocations was deduced from the X-ray spectrum analysis and were evaluated using the Williamson–Hall method. Structural parameters such as, lattice constants, unit cell volume, internal parameter and texturation have been calculated beginning with Nelson-Riley plots. The optical properties of ZnO nanosheets have been also studied and the band gap and Urbach energy where deduced. The photocatalytic performance was finally investigated by color removal measurements from dye contaminated water samples.


Magnetostatic Dipolar Anisotropy Energy of Ferromagnetic Thin Layers and Nanowires

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The computational effort to calculate the magnetostatic dipolar energy, MDE, of a system of N magnetic moment scales as N(N-1)/2, an O(N²) task. Compared with the calculation of the Exchange and Zeeman energy terms, this is the most computationally expensive part of any micromagnetic Monte Carlo simulation. To reduce the computational effort, the algorithm to calculate the MDE of periodic magnetic systems has been studied. We have found that, for some certain types of unit cells, many matrix elements of the algorithm are identical to others due to symmetry reasons and that the number of elements that should be calculated is approximately equal to N, an O(N) task, instead of N(N-1)/2. This reduces drastically the computing time of the calculation of the MDE of large magnetic systems. The use of the symmetries has been implemented and tested in a code to calculate the MDE and the dependence of the computing time on N has been analyzed. A parallelization of the
code has been also implemented and tested. Calculations of Ni and Co nanowires up to 30000 magnetic moments in the periodic unit cell have been carried out. Finally, the physical meaning and properties of the calculated magnetostatic dipolar anisotropy energies of Fe thin layers and Ni and Co nanowires are also discussed.

**NANO-201**

**Stability of self-assembled Cobalt nanoparticles under extreme conditions**

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Under specific conditions, magnetic metallic nanoparticles (NPs) are self-assembled in organized structures, called supracrystals [1]. This self-organization process takes place thanks to particle small size dispersion as well as the use of an adapted coating agent preventing coalescence and oxidation. Supracrystals possess a high potential in various fields, including electronics, charge transport and information storage. Nevertheless, their thermodynamic properties have been little studied, particularly under pressure. The present work aims at establishing the temperature-pressure phase diagram of supracrystals constituted of Co NPs hold together by lauric acid chains.

To this purpose, two experimental techniques were employed in combination with resistive heated membrane diamond anvil cell (mDAC) for the generation of the high pressures (0-20 GPa) and moderate temperatures (0-200 °C). Low wavenumber Raman scattering was used in order to determine both spherical and quadrupole vibrational modes of individual Co NPs [2]. In addition, a picosecond acoustics setup [3] was used to detect the collective vibrations of supracrystal, and their variations with P and T parameters. Physical properties of lauric acid was studied separately in order to identify its contribution to the properties of the supracrystals.


**NANO-202(2)**

**Development of a selective hydrogen leak sensor based on Pd incorporated ZnO nanowires on ITO substrate by spray pyrolysis method**

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A novel room temperature hydrogen sensor based on Pd decorated ZnO nanowires were fabricated on ITO glass substrate by spray pyrolysis method [1]. The effect of Pd dopant concentration on the structural, optical and
morphological properties of ZnO/ITO films was investigated. All the films exhibited excellent crystalline properties with preferred c-axis orientation. The blue shift in the PL peak suggests that the energy bandgap of ZnO can be tuned by varying the Pd concentration. The significant changes were recorded for 2% Pd doped ZnO, which show a transmittance of 95%. FE-SEM images of Pd implanted ZnO show perfectly aligned nanowires on the ITO surface with porous morphology, favorable for sensing. The hydrogen sensing response of ZnO/ITO films increased with increase in Pd doping concentration, which might be ascribed to a decrease in the crystallite size of ZnO and the effect of Pd catalyst in achieving electronic sensitization process [2,3]. The sensor successful detected as low as 100 ppm H\textsubscript{2} at room temperature. The improved sensor response was attributed to the spillover of palladium and the interaction between Pd and the ZnO nanowires support. The results suggest that Pd catalyst can alter the growth kinetics of ZnO nanowires by reducing the crystallite size and consequently enhance the sensor response [4]. The Pd:ZnO/ITO sensor prepared with 2% Pd revealed fast recovery time of 60s, suitable for high performance H\textsubscript{2} gas detection.


NANO-202

A novel synthesis of non-enzymatic H\textsubscript{2}O\textsubscript{2} sensor based on Pd: MnO\textsubscript{2} nanoparticles decorated carbon nanotubes/Ta hybrid nanocomposite

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In the present study, we report on the fabrication of Pd implanted MnO\textsubscript{2}/CNTs/Ta nanocomposite sensor for the electrochemical detection of H\textsubscript{2}O\textsubscript{2}. A novel method using a combination of electron beam evaporation and spray pyrolysis deposition was adopted for the fabrication of the hybrid nanocomposite [1]. The fabricated films were further characterised using X-ray diffraction Raman spectroscopy, scanning electron microscopy, and cyclic voltammetry [2]. XRD patterns of the hybrid composite confirmed the presence of preferential (002) plane of carbon and (110) plane of α-MnO\textsubscript{2} Raman spectral analysis show A\textsubscript{g} band corresponding to α-MnO\textsubscript{2} vibrational mode, and the characteristic D-band and G-band Raman feature for carbon nanotube [3]. SEM images revealed that the Pd incorporated α-MnO\textsubscript{2} nanoparticles were homogeneously distributed on the surface of carbon nanotubes with a narrow nano size distribution. Electrochemical H\textsubscript{2}O\textsubscript{2} sensors were constructed to demonstrate the sensing performance of pure MnO\textsubscript{2} and Pd:MnO\textsubscript{2}/MWCNTs/Ta electrodes by cyclic voltammetry. Compared with the bare MnO\textsubscript{2}, the Pd activated MnO\textsubscript{2}/CNTs/Ta electrode exhibited high electrocatalytic activity towards the reduction of H\textsubscript{2}O\textsubscript{2}, as surface modification provides continuous pathway for electron transport [4]. The sensor revealed a high sensitivity of 97.1 µA mM\textsuperscript{-1} cm\textsuperscript{-2} and the detection limit as low as 0.03 µM. The robust electrode material holds the potential for the development of high-performance electrochemical sensor for H\textsubscript{2}O\textsubscript{2} detection in other food products.

Ancient silver-based alloys objects are of a great interest from a historical, artistic and economical point of view because they were precious works of art or commonly used items as jewels, ornaments and amulets. Silver-based alloys were also largely used as monetary currency or like a form of saving, playing a relevant role for the development of economies. By means of the combined use of X-ray photoelectron spectroscopy (XPS), Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), scanning electron microscopy coupled with energy dispersive spectrometry (SEM+EDS) and optical microscopy (OM) we have studied the micro- and nano-chemical nature of the corrosion products grown on Ag-based artefacts found in different archaeological Italian sites. The results allow the identification of different corrosion products naturally grown during the long-term interaction between the silver-based alloy elements and degradation agents from the surrounding environment. The FTIR, XPS, SEM-EDS, XRD and OM results highlight the role of chlorine, that is always present in the patina as chlorargyrite (AgCl), and in few cases of bromine or iodine. Furthermore, our results reveal that chlorine often preferentially corroded the copper islands scattered in the alloy matrix giving rise to the formation of the dangerous copper-chlorine species such as atacamite and paratacamite. These latter compounds usually indicate the occurrence of the copper cyclic corrosion called by conservators “bronze disease”. Finally, different corrosion patterns have been observed with the outermost layers generally enriched of S, Ca, Al, Si and Fe, revealing a strict relationship between some soil constituents and the silver-based alloy that reacted forming different compounds in some case unusual.
NANO-204

Combined use of FE-SEM+EDS, TOF-SIMS, µ-FTIR, XRD and OM for the study of ancient gilded artefacts

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Gold coated commonly used copper-based objects such as studs, brooches, clasps and a small pendants, dating back to 16th–17th centuries CE, were studied by means of the combined use of FE-SEM/EDS, TOF-SIMS, µ-FTIR, XRD and optical microscopy (OM). In particular, the surface and subsurface chemical features of the gilded objects were investigated, revealing some aspects of the manufacturing methods as well as disclosing the mechanism of degradation occurring during the long-term burial in the soil and the agents involved in this process. Our investigation has made possible to identify the chemistry of the decorative Au layer deposited by using an amalgam, i.e. the fire-gilding, its structure and the corrosion products naturally formed from the interaction with the surrounding environment. The main degradation agents are chlorine, sulphur and phosphorous species that gave rise to the formation of different corrosion products. Indeed the corrosion phenomena are boosted by the metal galvanic coupling which makes gilded-metal art works unstable from a chemical-physical point of view. In perspective of preservation, our results suggest that it is important to prevent the interaction between moisture and nantokite (CuCl), located at the interface between the gilding layer and the substrate, in order to avoid further severe degradation phenomena such as “bronze disease” which transforms the copper substrate into a greenish powder.

NANO-205

Nanowire field effect transistors for sensing applications

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Major efforts are made nowadays for using nanostructures as building blocks for functional devices. The major goal is to use the properties induced by low dimensions for obtaining new and improved functionalities when compared to bulk material devices. Sensors are a type of devices which can fully benefit from these “exotic” properties of nanostructures. Nanowire channel field effect transistors represent a very interesting device to be used as a sensor. The particular geometry where the channel presents a high surface to volume ratio directly influences its sensing capabilities.

In the present paper we aim at describing our work related to different types of nanowire field effect transistors[1], [2]. Thus, we will present different approaches in preparing semiconducting nanowires. Physical, chemical and electrochemical methods of preparing nanowires will be shown. The influence of the preparation
method onto the electrical characteristics of the device will be also presented. Finally, we will focus on the methods related to device fabrication and the advantages and disadvantages of top down and bottom up methods.


NANO-206

Electrospun fibers for life sciences applications

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Electrospinning represents a very interesting technique due to qualities such as scalability, versatility and low cost[1], [2]. Based on a simple functioning principle the technique is investigated for a wide range of applications including flexible transparent electrodes, filters, cellular scaffolds or smart bandages. Practically, the technique consists in applying a high intensity electric field to a polymer solution droplet. A solution microscopic jet is formed which, as it solidifies, forms a micro- or nano-fiber. Many polymers can be employed as starting material including biopolymers such as collagen.

In the present paper, we will describe our results related to fabrication of polymer fibers and their use in the field of life-sciences and medical applications. Starting from simple biocompatible fibers obtained in a single step we will continue by describing the fabrication of complex fibers which can be employed as complex biosensors or biocompatible actuators. We will finally present the perspectives of the method applied to the above mentioned field.


Molecular biorecognition of glyconanoparticles by liver tumoral cells line

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Actually, the main goal in medicine to ensure successful treatment of diseases is to find a technology for a controlled targeted drug delivery. Nanotechnology offers the great opportunity to deliver designed vehicles to cells or tissue-specific. In this work, we modified bovine serum albumin (BSA) with lactose to obtain neoglycan (BSA-Lac) and promote sugar-lectin interactions. Subsequently, glyconanoparticles were synthesized with the ability of bio-recognition by the cells with galactose receptors. Results indicate that the BSA molecules were conjugated with 41 lactose, estimated by electrophoresis and confirmed by infrared spectroscopy and fluorescence. Using a water in oil emulsion method was obtained BSA-Lac nanoparticles with spheroid morphology and average size of 300-500 nm. Glycosylated nanovectors were specifically recognized by Ricinus communis lectins and endocytosed by Hep G2 cells line. The results indicate that the nanovectors could be aimed to the asialoglycoprotein receptors from liver cells and potentially used as transport anti-tumor drugs.

NANO-208

Membrane structure alterations on both \(\gamma\)-irradiated and stored human erythrocytes

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Storage and ionizing radiation of human red blood cells (RBC) are techniques often used in medical procedures. Those stressing agents produce morphological changes on RBC membranes and alter the normal shape and functionality of the cell membrane. In this work, we have investigated the morphological changes in human red blood cells at nanoscale by using both atomic force microscopy (AFM) and osmotic fragility (OF) to obtain the average roughness and fragility of their membrane surface, respectively. In addition, we followed the oxygen markers of hemoglobin (Hb) by Raman spectroscopy to detect the structural alterations induced by biochemical transformations in RBC. We done component principal statistical analysis (PCA) to address the main
contributions to oxygenation states. Our results indicate that RBC function is challenged when they are irradiated and stored. The membrane of RBC became more fragile despite the biochemical fingerprint of Hb remained unaltered. Furthermore, the storage procedure caused nanometric alterations over the surface of RBC membrane for both irradiated and non-irradiated cells.

NANO-209

Emissive Properties of Dye-Doped Polymer Nanofibers Produced by Electrospinning

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The electrospinning technique distinguishes itself among the numerous methods for obtaining polymer nanofibers due to the more growing interest induced by its proved utility. In particular, production of polymeric nanofibers in which different dopants are introduced was intensively studied in the last years because of the increased interest for the obtaining of functional electrospun nanofibers. Electrospinning is a facile method of obtaining polymer nanofibers with diameters from tens of nanometers to micrometrical sizes that are cheap, flexible, scalable, functional and biocompatible. Besides the multiple applications in medicine, polymeric nanofibers obtained by electrospinning permit manipulation of light at nanometric dimensions when doped with organic dyes or different nanoparticles. It is a simple technique that uses an electrical field to draw fine polymer nanofibers from solutions and does not require complicated devices or high temperatures. The advantages offered by the electrospinning technique when producing polymeric fibers are given by the simplicity of the method, the tuneability of the morphology allowed by the possibility of controlling all the process parameters (temperature, viscosity of polymeric solution, applied voltage, distance between electrodes, etc.), and by the absence of necessity of using harsh and supplementary chemicals such as the ones used in the traditional nanofabrication techniques. Luminescent nanofibers can be produced by electrospinning solutions doped with different dyes. Different morphologies of the electrospun nanofibers can be obtained for the same polymeric host when different parameters of the electrospinning process are used. Thus, we obtain tuneable optical properties of the electrospun nanofibers (e.g. changing the wavelength of the emission peak) by varying the dopants and the parameters of the fabrication method.

NANO-210

Fabrication and characterization of thin mico/nano-membranes for MEMS/NEMS applications

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In the last period different materials were used in order to obtain thin micro/nano-membranes with several applications, such as in energy harvesting, optical, and biological or space applications [1-5].
SU-8 is a highly cross-linked epoxy photopolymer which has been preferred as structural material for fabrication of biocompatible devices or as dielectric substrate [1-2]. Conductive or semiconductive materials such as polysilicon, monocrystalline silicon and metals are also preferred for micro/nano-membranes fabrication [3-5].

This work presents the manufacturing of thin micro/nano-membranes using the SU-8 photopolymer, polysilicon and gold materials as structural materials. The thickness of the SU-8 micro-membranes was selected between ~2-10 µm. The polysilicon membranes have a thickness of ~1 µm, and the gold thin membranes have a thickness of ~100 nm. Several characterizations (using SEM, AFM or nanoindentation techniques) were performed in order to analyze the obtained dimensions, the thicknesses, and the mechanical, and electrical properties of the fabricated membranes.

The fabricated micro/nano-membranes can be used for different applications in the broader fields of MEMS/NEMS due to their thermal, electrical and mechanical properties.

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Magnetite (Fe3O4) Nanoparticles: Synthesis, Characterization and Electrochemical Properties

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The spinel iron oxide or magnetite (Fe3O4) has unique behaviors including pseudocapacitive behavior [1]. This work reports the synthesized route, characterizations, and high specific capacitance of magnetite nanoparticles. Magnetite nanoparticles were prepared by the solvothermal method at 200oC for 8 h with 3 different amounts of poly (vinyl) pyrrolidone (PVP): 0.5 g, 1.0 g and 1.5 g. The prepared samples were characterized by XRD, TEM and XPS. The results from XRD show that pure phase of magnetite nanoparticles was successfully synthesized and all apparent peaks matched with cubic magnetite JCPDS No. 03-065-3107. The TEM images revealed microstructure of the samples which are round shape with mean particles size of ~ 50-90 nm. The high resolution peak at C1s of XPS clearly showed C-C, C=O and C-N bonds which matched with the characteristic bond of PVP [2] that confirmed the existence of PVP at surface of the prepared samples. For electrochemical
properties, the specific capacitance of the prepared samples was measured by a cyclic voltammetry method [3] in 6 molL⁻¹ of KOH at window potential of 0.65 V and scan rate of 2-200 mVs⁻¹. The specific capacitances of around ~ 400-520 Fg⁻¹ were observed. Among the prepared samples, the PVP 0.5 g showed the highest specific capacitance of 512.83 F/g at a scan rate of 2 mV/s. However, the specific capacitance was measured against various scan rates and the results showed that the specific capacitance tends to decrease at higher scan rate. Thus, these results indicated that the specific capacitance of the prepared samples may be not suitable for working at high scan rate.


NANO-212

Structural phase transition in Pt-Ag nanoalloys under high temperature

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The nanoalloys’ structural properties are highly complex and very interesting because of their size-dependent evolution. Only few studies concern the Pt-Ag system [1] and they are mostly numerical although this system shows an interesting but complex phase diagram [2] especially at low temperature: an ordered alloy is formed only at the equi-stoichiometry of Ag-Pt, and a quasi-complete immiscibility for the Pt-rich side compared to a partial immiscibility for an important Ag concentration. The objective is to establish the phase diagram of PtAg nanoparticles and to answer to the question does the surface segregation of silver dominate over the alloying effects? Pt-Ag nanoalloys were prepared by atomic evaporation using two separate sources operating simultaneously under ultra-high vacuum (UHV) conditions. The used experimental conditions lead to a Volmer-Weber growth mode operated on an amorphous substrate in order to avoid preferential orientation and to minimize substrate/particle interactions. This technique allows a complete versatility of size and composition depending on atomic fluxes of the two metals, the deposition time and the substrate temperature. Annealing treatments was also used to promote the isothermal equilibrium crystallographic structure of the nanoparticles. Combining transmission electron microscopy in HRTEM, STEM-HAADF (high angle annular dark-field) modes coupled to EDX analysis and grazing incidence X-ray scattering at the SIXS SOLEIL synchrotron beamline, we show for the quasi-equiatomic composition an alloy phase L1₁ with an important rhombohedral deformation can be obtained depending on thermal conditions. In addition, core-shell segregation for other particles compositions is observed in agreement with the Monte Carlo simulations[3].

Electron microscopy and X-ray-based techniques are probably the most commonly used to analyze the structure, the chemistry and the morphology of materials. With nanostructures, traditional X-ray or electron crystallography techniques mainly based on the crystal diffraction, fail because of their substantially limited length of structural coherence, and the lack of local order. In the case of nanoalloys, different strategies [1], [2] exist using various high-resolution electron microscopy techniques and various X-ray analysis tools based on X-ray absorption or scattering techniques. The principal difficulty with the application of these methods is to follow the nanoscale atomic arrangement during the structural evolution (growth or phase transition), especially in the case of AgCo or AgPt that present various configurations, like ordered, disordered, or segregated structures. The solution is to use methods that probe local and average features as well as nanometer to micrometer-sized data, providing highly complementary informations about the structure and morphology of nanostructures that are much powerful when used together: Ex-situ transmission electron microscopy in HRTEM and STEM-HAADF (high angle annular dark-field) modes and in-situ grazing incidence small and wide angle X-ray scattering (GISAXS and GIWAXS). An example is the Pt-Ag system which exhibits several phases an ordered alloy is formed only at the equi-stoichiomtery of Ag-Pt, and a quasi-complete immiscibility for the Pt-rich side compared to a partial immiscibility for an important Ag concentration. The objective is to establish a phase diagram at the nanoscale (1-5nm) especially the surface and mismatch effect leading to core-shell effect and also to study the reactivity of these particles especially in oxygen environment.


Biodegradable PHBHHx Fibers Reinforced with Capped ZnSe QDs for Photocatalysis

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Biodegradable PHBHHx-based fibers reinforced with uniformly dispersed capped ZnSe QDs, were successfully prepared via electrospinning method without any surfactant and with capping agent. Water soluble ZnSe quantum Dots (QDs) with a cubic zinc blende structure of 13 nm, were reinforced in the PHBHHx copolymer. Both pure PHBHHx and reinforced electrospun fibres were smooth and uniform. The XRD peaks of PHBHHx
were also observed in the patterns of ZnSe QDs indicating that the crystalline structure of both components was maintained. The presence of ZnSe QD did not affect the crystallinity of electrospun PHBHHx fibres. The smooth distribution of ZnSe QDs in the electrospun fibers was confirmed by SEM characterization and the elemental analysis also proved the presence of ZnSe QDs without any other impurity peaks on the copolymer matrix. The photocatalytic activity results confirmed that ZnSe reinforced PHBHHx fibres exhibited a strong photocatalytic activity by measuring the degradation of Azophlexin dye under sunlight irradiation. The fibers exhibited antibacterial activity against gram positive and gram negative bacteria. These sustainable fibres with antibacterial function show great potential to be an alternative to visible light active photocatalysts. On the whole, the results demonstrate that the incorporation of LCZS QDs on to PHBHHx polymeric matrix has a positive effect rendering improved biodegradable material that shows greater photocatalytic efficiency for degradation of azo dye.


NANO-218

Enhanced Dielectric permittivity with Retaining Low Loss in Poly(vinylidene fluoride) by Incorporating with Ag Nanoparticles Synthesized via Hydrothermal Method

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In this work, the dielectric properties of poly(vinylidene fluoride) (PVDF) are significantly enhanced by filling with Ag nanoparticles (Ag-NPs) prepared via a hydrothermal method using aloe vera plant-extracted solution as surface stabilizer and reducing agent. Ag-NPs/PVDF polymeric nanocomposites are prepared by a liquid-phase assisted dispersion and hot-pressing methods. Ag-NPs and Ag-NPs/PVDF nanocomposites are characterized XRD, TG/DTA, FTIR, SEM, TEM, and XPS techniques. Ag-NPs are well dispersed in the PVDF polymer matrix due to the modification of Ag-NPs surface. Interestingly, greatly enhanced dielectric permittivity of about 257.2 at room temperature and 1 kHz with low dielectric loss tangent (tanδ<0.5) is achieved. Excellent dielectric properties of the Ag-NPs/PVDF nanocomposites are described by the percolation effect and the formation of micro-capacitor in the PVDF polymer matrix.
NANO-219

High Dielectric Permittivity and Suppressed Loss Tangent in PVDF Polymer Nanocomposites using Gold Nanoparticle-Deposited BaTiO$_3$ Hybrid Particles as Fillers

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High dielectric permittivity with suppressed loss tangent can successfully be accomplished in PVDF polymer nanocomposites by using nano Au-deposited BaTiO$_3$ (Au-BT) hybrid particles as fillers. Nano Au-BT hybrid particles are prepared by synthesized by a Turkevich method. Two sizes of nano-Au particles with averaged sizes of 15 and 50 nm are designed and deposited on nano-BT surface. The morphologies of Nano Au-BT hybrid particles are revealed by field-emission scanning electron and transmission electron microscopes. Au-BT/PVDF nanocomposites are prepared by conventional mixed powder and hot pressing methods. Greatly enhanced dielectric permittivity of about 300 at 1 kHz is achieved in the Au-BT/PVDF nanocomposites, while the dielectric loss tangent is suppressed. It is also founds that the sizes of nano-Au particles, which are deposited on nano-BT surface, have an effect on the dielectric properties of the composites. The discrete growth of Au nanoparticles on INTO ceramic particles efficiently prevents the continuous contact between Au metallic particles in the PVDF matrix.

NANO-220

Polyaniline based Charcoal/Ni nanocomposite material for High Performance Supercapacitors

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A facile wet chemical approach was developed to synthesise the PANI/Charcoal/Ni nanocomposite, which was found to show significant electrochemical performance as supercapacitor. The as-prepared sample was characterized by various spectral and analytical techniques. The newly fabricated PANI/Charcoal/Ni nanocomposite electrode exhibited excellent specific capacitance with the maximum of 668 Fg$^{-1}$ at a discharge current density of 1 Ag$^{-1}$. Furthermore, the composite electrode displayed specific capacitance retention of 93% after 2000 charge–discharge cycles. Thus the PANI/Charcoal/Ni nanocomposite was proved to be as promising electrode material for high-performance supercapacitors.

NANO-223

Effect of nanocomposite MnO$_2$/Ppy/rGO on electrochemical sensing of methyl parathion

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In the present work, we report the synthesis of a new hybrid nanocomposite MnO$_2$/Polypyrrole (Ppy)/reduced graphene oxide (rGO)/GCE for high performance electrochemical detection of methyl parathion (MP). A novel single step process by chemical polymerization method was employed for the synthesis of MnO$_2$/Ppy/rGO nanohybrid. The sensitivity of the electrode was greatly enhanced by the influence of inducted polymer, Ppy encapsulated with MnO$_2$ nanoparticles. The structural, morphological and electrochemical properties of MnO$_2$, MnO$_2$/Ppy and MnO$_2$/Ppy/rGO were investigated by FE-SEM, HR-TEM with EDX, XRD and FTIR spectroscopy. The crystallographic properties revealed the tetragonal and rhombohedral crystal structure for MnO$_2$ and rGO, respectively. The combined characteristic peaks of MnO$_2$ and rGO were observed in the XRD pattern of nanohybrid composite. The appearance of broad characteristic peak at 23.6$^\circ$ confirmed the distortion of crystal structure of MnO$_2$ and rGO nanocomposite and the transformation of amorphous phase during the oxidation process of polymerization. SEM and TEM images revealed that the pure MnO$_2$ and Ppy nanoparticles show porous morphology with high surface area compared to rGO. The diameter of the MnO$_2$ and rGO particles was found to be in the range of 30-50 nm and 50-150 nm, respectively. The EDX result of the composite confirmed the effective doping of MnO$_2$, Ppy and rGO. The electrocatalysis of organophosphorus pesticide methyl parathion (MP) was investigated by Cyclicvoltammetric (CV) measurement. Further the effect of pH and concentration on the electrochemical behavior of MP was examined. The composite exhibited excellent electrocatalytic activity with enhanced peak current of 34.8 $\mu$A and reduction potential of 0.067 V. The improvement of electrocatalytic ability was exhibited with peak current value at 11.3 $\mu$A, 24.4 $\mu$A and -34.8 $\mu$A, corresponding to modified MnO$_2$, MnO$_2$/Ppy and MnO$_2$/Ppy/rGO, respectively. From the experimental data, it was evident that the current response of the modified electrode towards MP was linear in the range from 0.5 $\mu$M – 10 $\mu$M, with detection limit (LOD) of 81 nM and the sensitivity 8.22 $\mu$A $\mu$M$^{-1}$ cm$^{-2}$. The synergistic catalytic effect of the composite was more effective and hence enhanced the electrosensing ability of the electrode. The present work successfully demonstrated a simple, rapid, effective, economical and sensitive method for the detection of MP. The proposed method was furthermore employed for the determination of MP in fruits and vegetables samples.

**NANO-224**

Na$_{1/3}$Ca$_{1/3}$Bi$_{1/3}$Cu$_3$Ti$_4$O$_{12}$-Ni/Polyvinylidene Fluoride Three-Phase Nanocomposites with High Dielectric Permittivity and Low Dielectric Loss Tangent

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Na$_{1/3}$Ca$_{1/3}$Bi$_{1/3}$Cu$_3$Ti$_4$O$_{12}$-Ni/polyvinylidene fluoride (NCBCTO-Ni/PVDF) three-phase nanocomposites are fabricated. Phase compositions, microstructure and thermal properties of the NCBCTO-Ni/PVDF nanocomposites are characterized. Their dielectric properties are investigated as functions of temperature and frequency. The NCBCTO and Ni particles are used as fillers and found to be well dispersed in the PVDF polymer matrix. Significantly enhanced dielectric permittivity of >250, which is higher than that of pure PVDF polymer by a factor of 25, is achieved. Surprisingly, the dielectric loss tangent is very low ($\approx 0.07$ at 1 kHz). The dielectric properties of the NCBCTO-Ni/PVDF nanocomposites are discussed based on the interfacial polarization.

**NANO-225**

Low Dielectric Loss with Excellent Temperature Stability of Dielectric Permittivity in Ag/Ag-BaTiO$_3$ Hybrid Particles/PVDF Polymeric Nanocomposites

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In this work, the dielectric properties of PVDF polymer are symmetrically improved by incorporating with Ag and Ag-BaTiO$_3$ hybrid nanoparticles. Greatly increased dielectric permittivity ($\varepsilon'\geq200$) with retaining very low loss tangent ($\tan\delta<0.05$) in PVDF polymer is successfully accomplished. Notably, the temperature stability of the dielectric permittivity is improved with temperature coefficient at 140 °C less than ±15%, which is extremely hard to be realized at the same time for PVDF-based composites. We believe that this work provides comprehensive guidance for the design of new flexible dielectric materials with excellent dielectric properties.
Annealing Effect on Defect States and Electrical Property of ZnO Nanorods Prepared using a Hydrothermal Method

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1-D ZnO nanostructure have been regarded as a promising n-type semiconducting material due to its unique properties such as a wide band-gap (3.37 eV) and direct electrical pathway for electrons. In the present study, we synthesized ZnO nanorods (NRs) using a hydrothermal method, and investigated the effect of annealing temperature (150–750°C) on the morphology, crystallinity, defect states of the NRs and electrical property of the n-type ZnO NRs/p-type Si heterojunction diodes. While no appreciable change in the crystal structure was observed as the temperature increased, at 750°C the morphology changed from a NR to an irregular particle due to the partial melting of individual NRs. From the I–V characteristic, the as-grown and annealed NRs showed a well-defined rectifying behavior with turn-on voltage of ~2.1 V. The electrical conductivity of NRs was increased with increasing annealing temperature to 450°C, which was attributed to the increased charge carrier (oxygen vacancy) and crystallinity of the NRs, on the other hand, it degraded at above 750°C due to the decreased effective contact area.

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Effect of Diethanolamine on Morphology, and Photocatalytic Activity of Anatase TiO₂ Mesocrystals

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Anatase TiO₂ (a-TiO₂) mesocrystals are highly desirable for superior photocatalytic performance, owing to their large surface area and high crystallinity. [1] In this work, we synthesized a-TiO₂ mesocrystals with various concentration (0–5 mM) of diethanolamine (DEA) via a conventional hydrothermal process, and investigated the effect of DEA as capping agent on the morphology, and consequent photocatalytic performance of the a-TiO₂ mesocrystals. The pure a-TiO₂ was elliptical mesocrystal, having bipyramidal subunits with high portion of {101} facets. The percentage of {001} exposed facet of subunits increased with increasing DEA concentration. At high concentration of DEA (3–5 mM), especially, the a-TiO₂ particles did not maintained the mesocrystal forms due to the suppression of orientation attachment by DEA. In terms of photocatalytic effects, a-TiO₂ mesocrystals with 0.5 mM DEA exhibited enhanced photodegradation performance over the pure sample, but the photocatalytic performance was degraded for further addition of DEA. This was probably due to
the increase in the by-product, which was confirmed by FT-IR and TGA. The results suggest that the optimal DEA concentration is 0.5 mM in order to increase the ratio of \(\{001\}/\{101\}\) without further increase in by-product because the DEA acted as a double-edged sword in the photocatalytic activity.

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NANO-230

Effects of Calcination Temperature on Morphology, Microstructure, and Photocatalytic Activity of TiO\(_2\) Mesocrystals


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Anatase TiO\(_2\) (a-TiO\(_2\)) mesocrystal has been regarded as a promising photocatalyst because of its high crystallinity and large surface area [1]. In the present study, we synthesized a-TiO\(_2\) mesocrystals using a facile hydrothermal method, and investigated the effect of calcination temperature (100-800\(^\circ\)C) on their crystallinity, surface area, chemical composition, and photocatalytic activity. While no appreciable changes in the shape, dimension, and crystal structure of the a-TiO\(_2\) nanoparticles (NPs) were observed as the calcination temperature increased to 300\(^\circ\)C, the crystallinity improved with increasing temperature. The as-grown and 100\(^\circ\)C-300\(^\circ\)C calcined NPs exhibited a typical mesocrystal structure. The NPs begun to lose their mesocrystal form at 400\(^\circ\)C, and the specific surface area decreased with increasing temperature further owing to the reduced boundaries between subunits and surface roughness of the NPs. The photocatalytic activity of the TiO\(_2\) NPs improved when the temperature increased to 300\(^\circ\)C because of the enhanced crystallinity and elimination of by-products, on the other hand, it degraded at above 400\(^\circ\)C due to the decreased surface area. These results suggest that controlling the calcination temperature is an effective way to tailor the morphology, crystallinity, and photocatalytic activity of TiO\(_2\) NPs.

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Immunosensors are analytical devices in which the immunochemical reaction is coupled to a transducer. The peculiarity of all immunosensors is the specific molecular recognition of antigens by antibodies to form a stable complex. One of the main problems in the development of immunosensors is to overcome the complexity of binding antibody to the transducer surface. In fact, antibodies need to be immobilized with a high density and a right orientation to allow the easy and sensitive detection of antigens. In previous works\textsuperscript{1,2}, resorc[4]arene molecules proved to be able to immobilize enzymes and antibodies as biological component of ligand-based biosensor. With the aim to develop an artificial linker system for site-directed antibodies immobilization, we planned to synthesize a new potential crown-ether-based immunosensor\textsuperscript{1} with enhanced performance.


Surface Layer Effects in Sb-Doped TiO\textsubscript{2} Ceramics

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The effects of surface layer on the dielectric and electrical properties of Sb-doped rutile-TiO\textsubscript{2} (SbTO) ceramics are investigated. Surfaces of the as-fired and polished SbTO ceramics are characterized by XRD, SEM, Raman, and XPS techniques. The dielectric properties are investigated as functions of frequency and temperature over wide ranges. Interestingly, the as-fired SbTO ceramics can exhibit very high dielectric permittivity values ($\varepsilon^1>10^4$) with low loss tangent (tan$\delta<0.05$). Moreover, the nonlinear current-voltage properties are also observed. After removing the outer surface layer, tan$\delta$ values of the polished-samples are greatly increased, while their nonlinear electrical properties are eliminated. These can be recovered to the initial characteristics by annealing in air. Using an impedance spectroscopy analysis, it is clearly shown that the outer surface layer of the SbTO ceramics is an insulating layer. According to the Raman and XPS results, it is found that chemical states on the outer surface layer have influences on the dielectric and electrical properties of the SbTO ceramics.
The formation of defects on the surface that can confine free electrons in nano-region is studied by a first-principles study.

NANO-235

Direction Controlled Growth of In$_x$Ga$_{1-x}$As Nanowires

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Vapor phase growth of III-V compound semiconductor nanowires (NW) on group IV substrate is a technologically promising field which is eventually required in integrating III-V optoelectronics with Si microelectronics. Besides, such heterojunction based electronic devices have already shown promising performance enabling them to be utilized in next-generation nanoelectronic products. Control of growth direction of NW on a substrate is essential for device fabrication purpose. In order to realize planar and vertical NW devices on a same substrate material, the growth direction needs to be tuned. It is found in literature that III-V NWs generally grow in $<111>$ direction, however, growth direction other than $<111>$ were observed when substrates with different orientations were used. The controlling factors that decide direction of a NW are still unknown. In the present work, direction of growth of In$_x$Ga$_{1-x}$As NWs were found to change with the size of the catalyst, silver nanoparticles (AgNPs), which were employed to grow NWs on Ge (100) substrates by Metalorganic Chemical Vapour Deposition technique. Depending on the size of the catalyst, AgNPs, the NWs were found to grow in $<100>$, $<011>$ and $<111>$ directions. The observations were explained on the basis of classical theory of heterogeneous nucleation of NWs. Interestingly, below a certain size of the catalyst, Ge substrates got etched instead of any growth of NW which was attributed to Gibbs-Thompson effect. Two different kinds of etching were observed, viz. inverted pyramidal holes exposing the (111) planes, and non-selective cylindrical holes, depending on the size of NPs. The NWs were grown by using precursors, viz. trimethyl indium, trimethyl gallium and arsine in a horizontal reactor at 600°C on Ge substrates. Analysis from transmission electron microscopy along with selected area diffraction shows the single crystalline nature of the NWs.

NANO-239

Gas separation properties of Thermally Rearranged (TR) poly(benzoazole-co-amide) and zeolitic imidazolate framework based polymer mixed matrix membranes

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The membrane technology for gas separation has been developed rapidly in recent years. Many novel membrane materials were prepared and tested. In the last decade, thermally rearranged (TR) polymers has been reported as a new class of microporous materials group. They have demonstrated an extraordinary gas permeability and selectivity with large surface area, free volume elements, high rigidity and well-tuned pore sizes and size distributions. The size difference between the gas molecules and the membrane cavities enables a
membrane to separate gas molecules [1–3]. On the other hand, metal–organic frameworks (MOFs) containing mixed matrix membranes (MMMs) have recently received increasing attention because of the favorable compatibility with polymer chains. Among numerous MOFs, zeolitic imidazole frameworks (ZIFs) have risen to fame in porous material science over the last few years owing to their exceptional chemical, thermal stability and attractive molecular sieves for small gas molecules such as H2 and CO2.

In this study, we incorporated Zeolitic İmidazolate Framework-7 (ZIF-7) into thermally rearranged polymer HAB:ODA-IPCl poly(benzoxazole-co-amide) precursor for gas separation membrane fabrication. ZIF-7 was synthesized as porous filler materials. HAB:ODA-IPCl/ZIF-7 MMMs were prepared with varying amounts of ZIF-7 between 0-30 wt.%. Thermally rearrangement was performed to these membranes at 250 °C and 350 °C. Gas transport properties of the membranes were investigated by single gas permeation experiments of H2, CO2 and CH4 at 4 bar and 25 °C. With respect to their gas separation properties after ZIF-7 loading, these MMMs gave rise to TR-PBOs with high permeability and satisfactory permselectivity values for several gas pairs.

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**NANO-243**

**Thermodynamic description of order-disorder interface of nano-precipitates in Ni-Al alloy system**

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The high temperature microstructural stability of Ni-based superalloys is due mainly to the low free energy associated with coherent γ/γ’ interfaces. It has been shown that the coarsening rate of γ’ nano-precipitates inside γ matrix is controlled by solute diffusion through γ/γ’ interfaces which is known as a trans-interface diffusion-controlled coarsening (TIDC) mechanism [1]. Recent experimental investigations of γ/γ’ interfaces have revealed the presence of two interfacial widths, in which the width of the order-disorder transition zone is smaller than the width of the compositional gradient [2,3]. In the present study, thermodynamic modeling, complemented by experimental verification, have been employed to investigate the nature of order-disorder interface in the Ni-Al alloy system (as a nickel based superalloy model). The Gibbs free energy of γ and γ’ phases for the Ni-rich region of the binary system has been calculated employing two sublattice model [4,5]. In particular, the CALPHAD method has been used to interpret the structural and compositional gradient of γ/γ’ interfaces in a Ni-18Al (at.%) sample. Finally, a comparison has been drawn between the thermodynamic modeling results and the results of aberration corrected high resolution scanning transmission electron microscopy and 3D atom probe tomography (APT) analysis after long aging treatment of a Ni-18Al (at.%). The results indicate clearly that order-disorder transition zone can be determined as a function of compositional gradient and thermodynamic properties of the γ and γ’ phases.

In this paper, I consider quantum-relativistic aspects of a recent Drude-Lorentz-like model able to well describe the conductors in nanostructured form. The model is characterized by the assumption of a collective mode at a finite frequency, leading to the occurrence of anomalous charge transport. Considering appropriate scattering times, it is possible to mimic the infrared properties of oxides and semiconductors in the nano-form. The carrier current reverses its direction before decaying to zero and presents also damped oscillation in time, features possibly detectable with femtosecond time resolved techniques. The new presented result concerns the analytical form of the quantum-relativistic velocities correlation function, and its operation with specific examples related to Si, ZnO, TiO$_2$, GaAs, SWCN.


Structural and magnetic properties of FeNiCu nanostructured produced by mechanical alloying

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We investigated the magnetic, morphological, and structural properties of FeNiCu, the powder alloy are elaborated by mechanical alloying process for 10h with varying the Cu content. The aims of this work are to study the effect of Ni/ Cu ratio on the magnetic and microstructure properties. Coercivity and saturation magnetization increases from 105.4 Oe, 122.568 emu/g to 156.77  Oe, 140.679 emu/g respectively caused by the increase of the Cu concentration and dislocation density as well as the decrease of the crystallite size.
The effect of grain size on the strength and tribological behaviour of nanostructured and coarse-grained iron is presented. Nanostructured iron was obtained by equal channel angular pressing (ECAP) starting from as-received drawn coarse-grained ARMCO Fe cylinders of industrial purity (>99.85%). The strength of single-phase materials can be ascribed to grain boundary strengthening, work hardening or combination of both. Reciprocating sliding ball-on-flat tests performed in ambient air at RT were performed. The surface and subsurface states evolved due to thermal effects during sintering and to thermo-mechanical effects during sliding. That evolution is discussed in the light of the surface and subsurface microstructures developed during the sliding tests. The coefficient of friction is quite similar on both coarse grained and nanostructured iron samples. SEM-EDX reveals the presence of a surface tribolayer in the sliding tracks on both Fe-coarse and Fe-ECAP. That oxidized surface layer, of similar composition on both samples, is at the origin of the quite similar coefficient of friction noticed. That layer delaminates and regenerates as sliding progresses. The wear depth on Fe-ECAP is about 1 to 2 μm lower compared to Fe-coarse at all sliding cycles. At the turning points of the sliding tracks, shear bands are noticed on Fe-coarse but not on Fe-ECAP. The contact pressure is about 4 times larger than the estimated yield strength of Fe-coarse but only 6% above the estimated yield strength of Fe-ECAP. Plastic deformation is thus inevitable during the running-in cycles on Fe-coarse. Once running-in is completed, grain deformation and refinement obviously took place below the surface and is more evident on Fe-coarse than on Fe-ECAP due to the larger starting grain size of the former. The subsurface zones on both types of Fe samples developed quickly into a quasi-equilibrium morphology and composition as evidenced by a stable depth of deformation. Based on the observations made, it can be stated that, to harvest a more noticeable improvement by nanostructuring on wear resistance, the initial grain size should be below the grain size reachable by friction induced severe plastic deformation (SPD), namely ~200 nm in our case which was limited to discontinuous layers less than 1μm thick which can’t add much to the load-bearing capability of the material. SPD processing techniques like ECAP have limits to the achievable grain refinement.
atomic force microscopy (AFM), X-ray diffraction (XRD), Raman analysis, Fourier transform infrared spectroscopy (FTIR) and reflectance measurements. Results show that the evolution of the obtained nanostructures size as a function of the anodization time reveals two aspects of variation: an increasing phase that can be explained by a beginning of surface etching and a decreasing phase due to a lateral enlargement of pores created on the surface to the detriment of the nanostructures. Indeed, the morphological and structural characterization results highlight that the size of the formed nanostructures is strongly controlled by the current density and the laser excitation. We observe via The FTIR measurements that the surface of the porous silicon is rich in Si-H bonds responsible for the luminescence of the porous silicon. The reflectance spectra reveal a strong absorption above 500 nm in the visible spectrum. Indeed, the obtained nanostructures sizes promote the absorption in this range of wavelengths.

**NANO-249**

**Analytical Surface Potential Model for Columnar Nanocrystalline Silicon Thin Film Transistors**

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An analytical model to calculate the nano-crystalline silicon (nc-Si) ultra-thin film transistors (UTFT) surface potential is proposed. This pattern is based on an ultra-thin channel with a columnar morphology of nanocrystals. Our approach is based on the charge trapping at the grain boundary, the well-defined charge distribution into the inversion layer and the consideration of quantum size effects on dielectric constant and band gap. Results denote that, the surface potential is associated to the silicon crystallites size and geometry. The comparison of our results with existing research model shows a good agreement between the surface potential shapes and an interesting difference in the surface potential variation, caused essentially by the morphology considered.

The research in this area is more condensed on the current-voltage relationships, so several authors have made a considerable study concerning the surface potential for poly-Si TFTs. However, few researches have focused on the study of the nc-Si TFTs electrical characteristics. L.F. Mao has studied the impact of quantum size effects on the dielectric constant and the band gap on the surface potential of nc-Si TFTs, without considering the channel morphology. Experimental researches have been accomplished on ultra-thin silicon films in order to determine the crystallites shape. It has been clearly determined that the crystallites morphology is columnar, i.e. the columns were formed parallel to the growth direction. The purpose of this work is to propose an analytic approach in order to define the surface potential calculation by considering a columnar crystallites structure, defined by an accurate crystallites size and geometry.
NANO-251

Flexible Moisture Barrier with Organic / Inorganic Hybrid Structure for Organic Light-Emitting Diodes Using Roll-to-Roll Process

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OLEDs have a number of advantages for the utilization as lighting and display, such as low glaring, low power consumption, design flexibility and high color rendering index. Since organic materials are very sensitive to oxygen and moisture, OLEDs need to be protected from oxygen and moisture. Atomic layer deposition (ALD) can be utilized for manufacturing of moisture barrier due to its superior pin-hole free and good step coverage properties. But the ALD process suffers from a long process time and it is a critical problem to be solved for the commercial utilization. In this study, we fabricate the flexible moisture barrier for OLEDs by roll-to-roll process. Moisture barrier consist of inorganic/organic hybrid structure. Al₂O₃ thin layer was used as an inorganic layer deposited by ALD process. Trimethylaluminum (TMA) were used as aluminium precursor. Oxygen plasma was used as oxidant of ALD process. n-Hexane polymer grown by plasma enhanced chemical vapor deposition (PE-CVD) was used as an organic layer. The hybrid structure moisture barrier was deposited on plastic substrate. The moisture barrier property was measured by an electrical Ca test. We found out that hybrid structure of the flexible moisture barriers could effectively reduce the transmission of water for OLED display manufacturing. As well as roll-to-roll process is suitable process for reducing the process time of ALD.


NANO-252

Fabrication of Silver-nanowire Embedded Transparent Electrode with Light Extraction Layer for High Efficient OLEDs via Roll-to-Roll process

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The flexible organic light emitting diodes (OLEDs) are considered as the next mainstream in lighting and display industry due to their high efficiency and design flexibility. To make high efficient flexible OLEDs, there are several key factors like flexible transparent electrode, flexible encapsulation techniques, flexible substrates, and light extraction techniques. In this study, we were focusing on the flexible transparent electrode and light extraction layer for highly efficient flexible OLEDs. In our previous work, we successfully demonstrated the flexible transparent electrode with silver-nanowire via Roll-to-Roll process. [1] Fabricated transparent electrode showed high transmittance (over 85%), very low sheet resistance (~8 ohm/sq), and smooth surface (RMS value of below 7nm). In this study, we inserted the light scattering layer between silver-nanowire network and substrate for highly efficient OLEDs. First, Silver-nanowire dispersed solution (0.5 wt%) was bar coated on
donor PI film with the Meyer rod. After silver-nanowire coating, TiO2 nanoparticle-dispersed PMMA solution was spray coated on top of silver-nanowire. After the annealing process, barrier deposited acceptor PET film was laminated with UV-curable resin (NOA63). After UV exposure and delamination process, the silver-nanowire embedded UV-curable resin was transferred to acceptor PET film. All process was carried out with fully roll-to-roll equipment which can dramatically decrease the process time and cost. The fabricated hybrid electrode showed high haze (~60%) for light scattering to extract the light trapped in substrate and device with maintaining the sheet resistance and surface roughness. We also fabricated the OLED device with the hybrid electrode. Compare to reference one, the power efficiency of OLED device with hybrid electrode was 1.5 times better and the EQE was 1.3 times better.


NANO-254

Effect of anodizing potentials on corrosion behavior of anodic TiO2 nanotubes grown on Ti6Al4V substrates for dental application

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In this work, TiO2 nanotubes were grown by anodic oxidation on Ti6Al4V substrates in organic solution containing ethylene glycol and Ammonium fluoride at several applied potentials varied between 20 and 70V followed by thermal annealing at 450ºC for 2h. Different nanotubes diameters and lengths were obtained as revealed by scanning electron microscope. X-ray diffraction exhibits amorphous structure for all as-anodized nanotubes, it transforms to anatase after the annealing. Corrosion behavior was evaluated in artificial saliva at 37 ºC with neutral pH of 7.4 by using open circuit potential, cyclic polarization and electrochemical impedance spectroscopy techniques.

Polystyrene - Polyvinylidene Fluoride Blends

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Polyvinylidene fluoride (PVDF) is a special polymer, characterized by some crystalline structures responsible for ferroelectric, piezoelectric and pyroelectric features. PVDF has a glass transition temperature of -40 °C and a melting temperature of about 171 °C. PVDF has about 4 crystalline structures. Atactic polystyrene is essentially an amorphous polymer, characterized by a glass transition of about 100 °C. Blends of polystyrene and polyvinylidene fluoride (PS-PVDF) have been obtained by melt mixing, using a Haake Rheomix system equipped with two counter rotating screws. To achieve a proper dispersion of components the melt mixing was designed as a three step process, with a first segment at 190 °C and 60 rotations per minute (rpm) for 30 minutes, a second segment of 210 °C and 80 rpm for 15 minutes, and a last segment of 180 °C and 60 rotations per minute (rpm) for 30 minutes. Blends containing various amounts of PVDF have been obtained. The crystalline structures of PS-PVDF has been investigated by Wide Angle X-Ray Scattering by using a Discovery 8 Bruker spectrometer. Additional information was obtained by Raman spectroscopy (using a Renishaw InVia Raman confocal microscope operating at 532 nm and 785 nm). Non isothermal Differentials Scanning Calorimetry measurements at various cooling/heating rates have been performed in order to understand better the glass transition in PS and PVDF and the melting/crystallization process within PVDF.
secondary stages. These representation would similar at the Kelvin-Voigt model where the strain approach for the pure elastic material, with the difference decaying exponentially as, where C and Keywords: Findley’s Law, Kelvin-Voigt Creep model, Schapery equation, SMC composite creep behavior, …


NANO-260(2)

The Formation of Nanosize Pyramidal Meshes from Aluminum

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It has been reported [1, 2] that the electrochemical anodization of aluminum on a glass substrate can provide Al meshes with high optical transparency, a low electrical resistivity and good alignment properties for liquid crystal (LC) molecules on the substrate surface. This pyramidal morphology of Al mesh can provide good alignment properties of next generations of displays and can be one of the promising solutions for production of sensory microsystems and displays without indium-tin oxide films. For the formation of nanoporous alumina layers on glass substrate, we used the electrochemical anodization of aluminum layers at voltage of 50 V in oxalic acid solution. We founded optimal conditions of the anodization in oxalic acid solution, which allowed preparing nanostructured surfaces with a good optical transparency and conductivity, and good alignment properties of LC molecules on the substrate surface. Moreover, the transmittance of such pyramidal Al meshes depends on conditions of etching of anodic aluminum oxide. The pyramidal aluminum meshes was obtained by anodizing of thin film and chemical etching of porous alumina in the mixture of phosphoric and chromic acid. It had been shown that the pyramidal morphology of Al meshes could be prepared by chemical etching at temperature of 60°C. Using trade-off between the transparency and conductance of the nanosize pyramidal Al meshes we obtained resistance of 10-20 Ω per square sheet for holes with radius of 60-70 nm and interholes distance of 100 nm with pyramidal structures (highness of 30 nm).

The Chemical Deposition of Multicomponent Films in Nanoporous Anodic Alumina

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Thin oxide and sulphide films of Mo, W, Sn, Ti, Sm and combinations thereof, owing to high optical, electrical and physical-chemical properties, are widely used in the creation of efficient solar cells and different spectral range emitters, sensors, hydrogen fuel cells, as well as semiconductor photocatalysts and electrochromic displays [1]. One of the most promising way of obtaining of the functional materials with improved properties is the nanostructuring of thin films and the creation of the anodic alumina matrixes from nanostructures [1]. Nanoporous anodic alumina matrixes were formed by two-step anodizing of Al layers on Si substrates and then used as templates for deposition of multicomponent films on their surfaces. Matrix systems of oxide and sulphide films of Mo, W, Sn, Ti, Sm were synthesized by the electrophoretic layer-by-layer deposition and the dropping from the solutions and then were annealed at different temperatures [1]. The obtained multicomponent films were characterized by scanning electron microscopy, Raman spectroscopy, electron probe X-ray microanalysis and IR spectroscopy. The obtained matrix films had reproducible composition and structure and possessed certain morphological characteristics and properties. The self-organized nanosize structure of alumina matrixes allows to change the phase composition of synthesized films and to control over the sizes of crystallines in range from 40 to 150 nm. The developed technique based on the using of ordered AAM allows forming the functional films of different compositions with reproducible structure and properties.


Influence of carbon allotropes addition on the properties of the polystyrene composite board obtained from recycled expanded polystyrene

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At present, the companies producing polystyrene have very limited solutions in the use of recyclate (recycled polystyrene). Previous attempts to use recyclate resulted in lack of uniformity and worse parameters of the product. The competitive solutions in the scope of re-use of recycled polystyrene for the production of new polystyrene products are based on the addition of a recyclate of appropriate density to the nonsegregated foamed raw material prior to the block’s molding process. The addition of various carbon allotropes (carbon
nanotubes (CNT), graphene) will help improve the performance of the obtained materials obtained so as to meet European standard EN 13163.

The research involved a stereographic analysis of expanded polystyrene sections obtained for different applications. Depending on the application, attention is paid primarily to the thermal conductivity (thermal shields) and mechanical strength (for construction and packaging purposes). In the case of food packaging, the coherence of the cellular structure and water absorbability resistance are also essential. The study was mainly focused on influence of graphene and CNT on material structure and mechanical properties. SEM examinations of cell structure, wall thickness, shape and size were performed.

**NANO-263**

**Detonation nanodiamond as biological barrier and performance enhancer in expanded polystyrene boards**

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Detonation Nano-Diamond (DND), thanks to the presence of free electrons on the extended surface, have antioxidant properties. Capability to uptake of free radicals makes DND a great material to create a specific ‘biological barrier’. Therefore, it can be used in food packaging made of expanded polystyrene foam (EPS). Moreover, the addition of nanodiamond substantially changes the physical and mechanical properties of the material. The study was focused on the influence effect of DND on the intermediate beads formation, and then on a density and uniformity of the final product. Thus, DND has been added at the stage of EPS molding.

In this study, biological properties were validated using foodborne bacterial and fungi pathogens (i.e. *E. Coli, St. Aureus, St. Epidermis, C. Albicans*). Furthermore, research was related to the coverage of EPS granules by DND (using SEM examination) and to the impact of this coverage on the mechanical and tribological properties of final material. The thermal conductivity and compressive strength were also measured. Preliminary results are very promising and show the possibility of obtaining products with much higher performance than commercially used.
The Role of Interstitial Clusters in Ion Beam Induced Bending

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Ion-induced bending phenomena were studied in free-standing nanosized Al cantilevers with thicknesses in the range of 89 to 200 nm. The objective is to present a predictive and useful model for the fabrication of micro- and nanosized specimens. Samples were irradiated in a Tescan Lyra dual beam system with 30 kV Ga⁺ ions normal to the sample surface up to a maximum fluence of ~2x10²¹ Ga ions/m². Irrespective of thickness, all samples bent initially away from the Ga⁺ beam; as irradiation proceeded, the bending direction was reversed. The Al cantilever bending behavior is discussed in terms of depth dependent volume change due to implanted Ga atoms, radiation-induced point defects and interstitial clusters. A kinetic model is designed which is based on a set of rate equations for concentrations of vacancies, interstitial atoms, Ga atoms and clusters of interstitial atoms. The bending crossover is explained by the formation of sessile interstitial clusters in a zone beyond the Ga⁺ penetration range. Model predictions agree with our experimental findings.